Electrical Review

THE PIONEER ELECTRICAL WEEKLY OF AMERICA.

VOL. XXXVIII. No. 1. NEW YORK, SATURDAY, JANUARY 5, 1901. ISSUED WEEKLY.

ELECTRICAL REVIEW

Park Row Building,
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Subscriptions to the
ELECTRICAL REVIEW.

One Year, United States and Canada, - - $3.00
One Year, Foreign Countries, - - - - - - 5.00
Single Copies, each, - - - - - - - - .10
Copies can be supplied for only one year back at 25 cents each.

1901.

To all of its readers and all of its friends the ELECTRICAL REVIEW wishes the happiest New Year and New Century. Judging from the point of view of our present prosperity and the outlook for the future that is opening before us, it seems as if all of us have reasonable expectations of being happy, contented and prosperous during the ensuing year and those that follow it.

The new century breaks upon this country full of promise and hope for extension and enlargement in every direction. The chance of fate has put into our hands new and magnificent opportunities. It is confidently believed, by those whose acquaintance with our industrial and political situation is the best, that our future is brighter to-day than it has ever been. We have broken away in some measure from the traditions of our national childhood and are entering upon the vigorous period of activity which we believe is our destiny. In our own chosen profession and trade the future seems brilliant and full of promise and, as we look back over the last two years and see the wonderful strides we have made in all the various branches of our activity, we can turn our faces to the front with confidence in the outcome of both the immediate and the more distant future.

Notwithstanding the opportunity that is presented to us by the condition of affairs in our own country and abroad we must not forget that it is essential to seize the opportunity while it is here, and to work hard for the good things that we desire to enjoy. Great gifts do not come either to nations or to individuals entirely by chance; circumstances present the opportunity and those who are worthy seize upon it and improve it. An opportunity is a license to work hard and this is the situation in which we find ourselves at the beginning of the new year and the new century.

ENGLAND'S COAL SUPPLY.

There has been no little alarm created in the British Isles during the last year by the prospect of a failure in the British coal supply. It is believed that all of the coal in the islands has been located, and the increasing difficulty of working the numerous mines (many of which have now gone to great depths) and the consequent rising price of fuel have troubled the manufacturers and the general public with a fear that the supply would eventually give out altogether and that, in the meantime, the manufacturing prestige of Great Britain would be lost through the easy competition of countries better supplied with coal. The London *Spectator* has urged wisely that electrical distribution of power will accomplish much in reducing the waste of coal now going on, and so far has spoken with good sense. When it has urged, however, that electricity can be made to supersede steam power it has evidently forgotten that steam power is the most available means at hand for the generation of electricity.

Much of the waste of coal would be avoided by the introduction of electricity upon the railways and in the workshops of the United Kingdom as a motive power, the current being derived from large units of high economy operated in the vicinity of the coal mines. While this would be a palliation of the evil it would be by no means a cure, and we are irresistibly led to the belief that British engineers will, sooner or later, seize upon every available water power in their country and harness it to the wheels of commerce.

When this is done there will be a greater or less amount of coal used, but we are to remember that we stand at the threshold of a century in which great things will certainly be done in the generation and distribution of electric power and in improving means of transportation of all kinds. Long before the coal measures of England are exhausted the chances are that the abundant natural forces of the winds, the waves, the tides, the sun's heat and possibly even the interior heat of the earth will be utilized and coal will no longer be needed except in certain metallurgical processes. With the improvement in transportation that is sure to come coal can probably be delivered in Great Britain at a less cost than is now required to mine it. For all of these reasons it seems unnecessary for the British public to feel alarmed at the increasing scarcity of natural fuel. They can safely trust their engineers and inventors to bring them through this difficulty and to solve each problem as it arises.

TELEPHONE ENGINEERING.

Once upon a time—and it was not so very many years ago—it was regarded as somewhat singular that a man should wish to specialize so far as to call himself an electrical engineer. Electricity has grown so fast, though, that nowadays even electrical engineers are beginning to be highly specialized, and we find railway, lighting, power, electrochemical, telephone and telegraph engineers, with perhaps other species of the genus to come later. It seems time that somebody said a few words, though, as to the importance and difficulty of the duties of the telephone engineer as contrasted with other varieties of electricians.

It is a curious fact, though one not generally known, that in an installation costing a given sum of money more engineering work has to be done if the plant happens to be a telephone exchange than if it is any other variety of electrical engineering installation. The telephone engineer has to consider a vast complexity of circuits working almost under limiting conditions of delicacy of current, and he has to maintain large numbers of small but complicated and delicate fixtures in premises over which he has no immediate control. His exchange is almost infinitely more complicated and difficult to design than a lighting station and he has to struggle also with an element which does not enter the work of his colleagues in other branches. This is the time element. In an ordinary central station the problem is to maintain the proper electrical pressure on the mains and enough capacity to supply the demands upon the plant. In the telephone exchange, however, not only must circuits be maintained and instruments kept in working order, but the operation necessary in meeting the demands of a customer must be conducted in the absolute minimum of time. In other words, the telephone engineer has to struggle for efficiency not only in his apparatus and appliances, but also in the large force of operators, inspectors and other employees. Further than this, nothing seems so much to bring out the impatience of the public as telephone service. While some of the complaints that are received at exchanges are reasonable, another name would better fit the majority of them, and against all this the telephone engineer is constantly contending in the effort to make his service as nearly perfect as possible.

An engineer in charge of a trolley road or lighting plant does not frequently have to worry himself over small currents and the problems presented by induction and capacity, and in comparison with his less fortunate brother of the telephone exchange he has plain sailing. The telephone man, however, must not only know his own work but he must be sufficiently familiar with that of the electric light or railway station to avoid the multiplicity of troubles which may easily come through some entanglement of his lines with theirs. In a modern exchange, too, he must be learned in such subjects as rotary converters, storage batteries, motor-dynamos and in a bewildering variety of applications of electricity not immediately pertinent to his own subject.

It seems therefore that his work is as hard as any and that the talents required for its successful prosecution must be very considerable. Perhaps electrical engineers in general may not agree with the statement that the telephone man's lot is the hardest and the demands upon him the greatest that are made upon any members of the profession, but it is certain that the telephone man himself will agree heartily and entirely with this statement.

CONSTANT-CURRENT TRANSMISSION.

On another page of this issue is described and illustrated an interesting case of power transmission by M. Thury's system, employing constant direct currents and using series generators and motors. The system has never obtained recognition in this country—at least in so far as large power units are concerned—although some years ago, as will be remembered, there was a considerable number of motors operated on arc light circuits in various cities of the United States. The main objections to the system seem to centre around commutator difficulties and the enormous electrical potentials which must be brought into the operating machinery. Transformation in the case of direct current is so difficult and so expensive that it can not be employed commercially, so the main line potential has to be brought into the motors and generated directly upon the dynamo. The system is of interest, however, as an example of a traditional and now outgrown method. It can hardly be thought likely that it will ever find extended use again or ever be a serious competitor of the polyphase systems now in such general use.

When the proposed changes in Greater New York's charter are made, it will be in order to put the inspection of electric wiring, now under the department of public buildings, lighting and supplies, in the hands of some other branch of the city organization. A recent rumor states that this department is to be abolished, and its work turned over to the heads of different departments. Several times this branch of the city's service has been stigmatized as the "janitor's department," including, as it does, everything from the inspecting of public buildings to the purchase of soap and the hiring of charwomen. In such a department electrical inspection is out of place. Its working head is now, by reason of the endless technicalities involved, compelled to rely upon the ability of his subordinates. This work was formerly done by the fire department, and just why it was placed in charge of a man who is probably very willing to be rid of it is not apparent. Burdened with more work than any other one of the city's departments, the choice of the department of public buildings, lighting and supplies for this service was a mistake at least. Perhaps as good a suggestion as can be made is that the department of buildings, whose commissioner and chief executive is a practical engineer, should assume control of the inspections. The advantages that would accrue from having a thorough, practical engineer in charge of such work can not easily be overestimated. He would be able and willing to check the work of his inspectors, he could be held personally responsible for the work of his department, and the safety of property, to say nothing of the peace of mind of the owners, who would be more secure, while the liability to loss of the insurance companies—a not unimportant factor—would be accordingly lessened.

Science Brevities

Electro-Capillarity of Mixtures—M. Gouy has studied the effect of adding a small quantity of an "active" salt (in the capillary sense) to a solution of a comparatively inactive salt. Such active salts are chiefly iodides, bromides, platino-cyanides, sulpho-cyanates, and sulpho-carbonates. They produce, even in very dilute solutions, a considerable depression of the maximum deviation. If 0.01 gramme-equivalent of such a salt is added to a litre of a normal solution of an inactive salt, the mixed solution behaves practically as if it contained only the former salt. In spite of the great difference of concentration, the active salt practically supplants the inactive. The effect of adding the active body, say an iodide, to a less active one, say a bromide, is always to reduce the surface tension. Bromide added in small quantities to iodide produces no effect, but in some cases the depression of the maximum is increased by the presence of an inactive body. The author supposes, says an *Electrician* abstract, that there exists an elective action at the mercury surface which produces an accumulation of the anions of the active body rather than of the others. If the active anions are few the state of equilibrium takes some time to establish itself, and we then have a case of electro-capillary viscosity.

Railway Traction—In a leading article a German contemporary comments on the increasing practicability of equipping standard-gauge railways for electric traction, says the *Electrical Engineer*. Since considerable distances are involved by railway work, the transmission of energy by means of high-tension, multiphase currents is a fundamental basis for such projects opines the authority in question. But the transformation of the energy prior to its final conveyance to the propelling motors of the trains may be accomplished in various ways. As a matter of fact, three systems have already been tried. One of these consists in the conversion of the high-pressure, multiphase currents into continuous currents of moderate pressure by means of fixed transformers and rotary converters placed in substations. In this case the arrangements are similar to those prevailing for ordinary tramways, except that they are on a correspondingly larger scale. A second system consists in converting the high-pressure, multiphase currents into multiphase currents of moderate pressure, and conveying the same to the trains through three separate conductors. In this case at least two special conductors are requisite, while the rails may constitute the third, and the trains would, of course, be equipped with multiphase motors. The third system consists in conducting the high-pressure, multiphase currents by means of three overhead wires direct to the train, which is equipped with transformers and multiphase motors. As regards the relative values of the three systems, expert opinions differ. Each has its particular advantages and disadvantages. To the first-mentioned system belongs the merit of having the least number of untried combinations, besides that of being already extensively adopted. But as a set-off against the great advantage of securing complete control of the speed and of obtaining high efficiency at all speeds when continuous-current motors are employed, the disadvantage of having to take fairly large currents from the working line must be taken into account. The same disadvantage holds for the second system, which does not, however, combine the easy regulation and high efficiency of the motors as a compensation, for which reason it has been adopted only where fairly constant speed can be maintained. The third system combines the great advantage of easy transmission, and, therefore, permits the use of heavy trains designed for high speeds, by virtue of which its application for standard-gauge railways gives great promise of success. Experiments in Lichterfelde have proved the practical possibility of this system, and a trial on a larger scale is to be made on the military railway to Zossen.

Gas Batteries—Chemical studies have enabled Herr F. Haber to put forward the proposition that the oxidation potential of hydrogen peroxide, together with its reduction potential, represents the oxygen potential. Mr. Fournier d'Albe says this result, which may be deduced from thermodynamical considerations, implies that for fixed values of the hydrogen concentration and the oxygen concentration there is only one stable value for the hydrogen peroxide. That value obtains at the oxygen electrode, and remains constant as long as that electrode operates in a reversible manner. But the concentration of the hydrogen peroxide does not effect the dynamics of processes in which the maximum work is yielded, and which can be reduced to the work of a battery of the form

Metal | metallic ions | hydroxyl ions | oxygen electrode.

When the processes are rapid, however, certain metastable conditions may occur, and it is to such conditions that the author attributes the phenomena observed at a platinized platinum electrode dipping into hydrogen peroxide solution, as well as the catalysis of hydrogen peroxide by finely divided platinum.

Use of a Polarizing Cell in the Telegraphone—It has already been announced that the introduction of a polarizing cell in the circuit of the recording electromagnet considerably increases the sharpness and clearness with which the sound is rendered. This observation is now explained by Herr E. Ruhmer, whose explanations are thus abstracted in the *Electrician*. The preliminary magnetization probably never exceeds 12,000 units, and after the wire leaves the neighborhood of the electromagnet its magnetic intensity probably falls to about 8,000 units. When the wire is used for recording, its remanent magnetism will then induce pretty high magnetizations in the core of the recording electromagnet, with a maximum of some 8,000 units. Now, this value, when looked up on the curve of magnetization, is seen to correspond to a low permeability, where comparatively large variations of the magneto-motive force only produce small variations of the magnetic flux, and therefore also small amplitudes of the magnetic waves to be impressed upon the wire. But for loud records it is important that the variations of the magneto-motive force should take place on a steep portion of the magnetization curve. That condition is fulfilled by introducing a cell in the circuit which shall just compensate the magnetism induced by the wire in the core of the electromagnet. In Poulsen's case, the electro-motive force required is only one volt.

Separation of Wireless Messages—M. P. Jégou has devised a differential apparatus, which while not preserving the secrecy of wireless messages, enables the sender to communicate at will with one or another of two stations situated at different distances, says an *Electrician* abstract. The principle adopted is that already proposed of employing mast-wires of different ranges. Four such mast-wires are employed, two at the sending station and two at the receiving station. Their heights are so arranged that one of them covers, say, a range of five miles, while the other does not. The circuits of the coherers attached to the two mast-wires are so arranged that their simultaneous action produces no effect upon the galvanometer. But at a distance of five miles the galvanometer will respond to a message from the sending station addressed to both coherers, as only one of them is brought into action. At half that distance, when both coherers are within range, no effect is produced on the galvanometer. Thus, at all events, something of the nature of separation by distance is obtained, though it is open to the obvious criticism that complete neutralization of the two effects is only produced at one definite value of the distance. It would be better if the message itself were limited to this value instead of the absence of the message.

THE THEORY OF ALTERNATING DYNAMO-ELECTRIC MECHANISMS—X.

BY W. ELWELL GOLDSBOROUGH.

When the harmonic equations that express the instantaneous values of the impressed electro-motive force and the current influencing any circuit are known the energy developed in the circuit is readily determined analytically. The rate at which energy is imparted to the circuit during any instant is equal to the $(e\,i\,d\,t)$ divided by the increment of time, $d\,t$: i.e., the

$$\text{power at any instant} = \frac{e\,i\,d\,t}{d\,t},$$

if therefore the equation of the impressed electro-motive force is of the form,—

$$e = E_1 \sin(\omega\,t + \theta_1) + E_3 \sin(3\,\omega\,t + \theta_3), \qquad (109)$$

and the equation of the current has the form,—

$$i = I_1 \sin(\omega\,t + \phi_1) + I_3 \sin(3\,\omega\,t + \phi_3) + I_5 \sin(5\,\omega\,t + \phi_5) \qquad (110)$$

the mean power developed in the circuit will equal,—

$$\int_0^{2\pi} \frac{e\,i\,d\,t}{2\pi} = \frac{1}{2\pi}\int_0^{2\pi} [E_1 \sin(\omega\,t + \theta_1) + E_3 \sin(3\,\omega\,t + \theta_3)][I_1 \sin(\omega\,t + \phi_1) + I_3 \sin(3\,\omega\,t + \phi_3) + I_5 \sin(5\,\omega\,t + \phi_5)],$$

$$= \frac{1}{2\pi}\int_0^{2\pi} [E_1 I_1 \sin(\omega\,t + \theta_1)\sin(\omega\,t + \phi_1) + \qquad (a)$$

$$E_3 I_3 \sin(3\,\omega\,t + \theta_3)\sin(3\,\omega\,t + \phi_3) + \qquad (b)$$

$$E_1 I_3 \sin(\omega\,t + \theta_1)\sin(3\,\omega\,t + \phi_3) + \qquad (c)$$

$$E_1 I_5 \sin(\omega\,t + \theta_1)\sin(5\,\omega\,t + \phi_5) + \qquad (d)$$

$$E_3 I_1 \sin(3\,\omega\,t + \theta_3)\sin(\omega\,t + \phi_1) + \qquad (e)$$

$$E_3 I_5 \sin(3\,\omega\,t + \theta_3)\sin(5\,\omega\,t + \phi_5)]\,d\,t \qquad (111) \qquad (f)$$

If we apply the transformation formula (67) to each of the right-hand members of equation (111), and integrate as in equation (68), we find,—

$$\int_0^{2\pi} \text{of } (a) = \frac{E_1 I_1}{2}\int_0^{2\pi} [\cos(\theta_1 - \phi_1) - \cos(2\,\omega\,t + \theta_1 + \phi_1)]\,d\,t = \pi\,E_1 I_1 \cos(\theta_1 - \phi^1)$$

and, therefore,

$$\int_0^{2\pi} \text{of } (b) = \pi\,E_3 I_3 \cos(\theta_3 - \phi_3),$$

and, again,

$$\int_0^{2\pi} \text{of } (c) = \frac{E_1 I_3}{2}\int_0^{2\pi} [\cos(-2\,\omega\,t + \theta_1 - \phi_3) - \cos(4\,\omega\,t + \theta_1 + \phi_3)]\,d\,t = 0,$$

therefore

$$\int_0^{2\pi} \text{of } (d), \text{ and of } (e), \text{ and of } (f) \text{ each}$$

equals zero.

Substituting these values of the several integrated terms in equation (111), we get finally,—

$$\text{The mean power} = \frac{E_1 I_1}{2}\cos(\theta_1 - \phi_1) + \frac{E_3 I_3}{2}\cos(\theta_3 - \phi_3). \qquad (112)$$

By extending this proof it can be shown that, *in any case*,—

When the impressed electro-motive force and current are harmonic functions of the time, whether simple or complex, the mean power developed in the circuit is equal to one-half the sum of the products of the constants of all the harmonics having the *same frequency* that appear in either equation by the cosines of the differences of their epoch angles.

In the case of the complex harmonics of equations (109) and (110), it is seen that the fifth harmonic in the current equation does not affect the mean power developed in the circuit in the least; it is simply a wattless harmonic that somewhat distorts the power curve, but since it adds and subtracts equal amounts of power during a complete cycle, its average effect is zero.

In any case then, where the impressed electro-motive force is a simple harmonic function, however complex the equation of the current may be the mean power will be equal to one-half the product of the maximum value of the impressed electro-motive force, by the constant term of the principal function of the current, by the cosine of the angle of lag of the principal function of the current behind the impressed electro-motive force. That is, the

$$\text{mean power} = \frac{EI_1}{2}\cos(\theta - \phi_1) \qquad (113)$$

and the mean power effect of all the "higher" current harmonics *will be zero.*

In applying the analytical methods just developed to the solution of the problem cited on page 649, we must know the harmonic equations of the impressed electro-motive force and current.

The impressed electro-motive force is a simple harmonic wave, and is expressed by the equation,—

$$e = 100 \sin \omega\,t = 100 \sin(628t). \qquad (114)$$

The current wave is a complex harmonic and is expressed by the equation,—

$$i = 60 \sin(\omega\,t - 30°) + 10 \sin 3\,\omega\,t = 60 \sin(628\,t - .524) + 10 \sin(1885\,t), \qquad (115)$$

which consists of a principal function and its third harmonic.

Knowing these equations it is a simple matter to determine the mean power developed by the alternator. Substituting in equation (112),—

$$\text{mean power} = \frac{EI_1}{2}\cos 30° = \frac{100 \times 60}{2}\,.8663 = 2598 \text{ watts.}$$

The third harmonic is entirely negligible since the impressed electro-motive force is a simple sine curve, and therefore, $E_3 = 0$, as also E_5, E_7, etc., and I_5, I_7, etc. The power developed would be just the same, then, if the current was a simple harmonic expressed by,—

$$i = 60 \sin(\omega\,t - 30°).$$

From this it must not be supposed, however, that, when the impressed electro-motive force is a simple harmonic function, the equation of the equivalent-current curve and the principal function of the current equation will be identical. If we apply equation (105) to the determination of the virtual values of the electro-motive force and current, we find that.—

$$E = .707 \times 100 = 70.7 \text{ virtual volts,} \qquad (116)$$

and

$$\bar{I} = \sqrt{(60)^2 + (10)^2} = 43.01 \text{ virtual amperes.} \qquad (117)$$

Therefore, by the method given on page 684, the cosine of the angle of lag of the equivalent current curve is,—

$$\cos\phi' = (\text{mean power}) \div (E\bar{I}) = 2598 \div (70.7 \times 43) = .85435$$

and

$$\phi' = 31°\ 19'. \qquad (118)$$

Moreover, since $\bar{I} = 43$, the maximum value of the equivalent-current curve will be,—

$$I' = 43 \div .707 = 60.8 \text{ amperes,} \qquad (119)$$

and therefore the *true* equation of the equivalent curve will be,—

$$i' = 60.8 \sin(\omega\,t - 31°\ 19'). \qquad (120)$$

This makes it evident that the maximum value and the angle of lag of the equivalent current are greater than the constant term and angle of lag of the principal function of the current equation on account of the presence of the third harmonic, which increases the virtual value of the current although it does not affect the mean power. By comparing equation (120) with the equation of the equivalent-current curve obtained by the usual working methods it is seen that the two are practically identical. This accords with the statement made in the middle of page 684.

The resistance of the circuit that is supplied by the alternator is 1.04 ohms, and the curve (e_r) of Fig. 29, which repre-

sents the instantaneous values of the effective electro-motive force, is practically identical with the curve (i) of Fig. 27, since $e_r = R\,i$.

If we subtract the ordinates of the curve (e_r) from the corresponding ordinates of the curve (e), we will determine the instantaneous values of the apparent counter electro-motive force of self-induction. A series of these values are tabulated in Table II, in the column marked (e_l), and are graphically represented by the curve marked (e_l) in Fig. 29. This curve shows that the counter electro-motive force has much the same wave-form as the effective electro-motive force. Its ordinates are proportional to the rate of change of the magnetization through the inductive portions of the circuit, and therefore, from it, by the method developed on page 568, the curve that represents the variations in the magnetic flux can be derived. The curve marked Φ in Fig. 29 has been developed in this manner, and its ordinates are equal to the values of $\mathcal{B}$ tabulated in Table II, and are, therefore, proportional to the total magnetic flux.

The curve of magnetization Φ approximates the sine wave-form much more nearly than either the current or counter electro-motive-force wave. It is a maximum at the instant that the current is a maximum, and the counter electro-motive force is zero; and is zero at the instant that the counter electro-motive force is a maximum, as is to be expected.

The dotted curve in Fig. 29 marked (e_r') is the curve of equivalent effective electro-motive force. It is plotted from its equation, obtained by multiplying equation (120) by the resistance (R = 1.04 ohms) of the circuit, and is, therefore, practically identical with the equivalent-current curve, and lags 51° 19′ behind the curve of impressed electro-motive force. The curve of equivalent counter electro-motive force is marked (e_l') in Fig. 29; its ordinates are the differences obtained by subtracting the ordinates of the curve (e_r') from those of the curve (e). It is, of course, a sine curve, and is 34° 22′ in advance of the impressed electro-motive force.

The curve of equivalent magnetization has been determined from the curve (e_l') by the method developed on page 568 and is the dotted curve marked (Φ') in Fig. 29. It will be seen that the curve (Φ') reaches its maximum value 7° 38′ later than the curves (Φ) and (i) or (e_r), and it lags 24° 19′ behind the equivalent electro-motive-force curve (e_r'). This indicates that the apparent lag of the magnetization is not so great as its real lag, and also that, as in the case of the current, the maximum value of the magnetization is slightly greater than the maximum value of the equivalent magnetization.

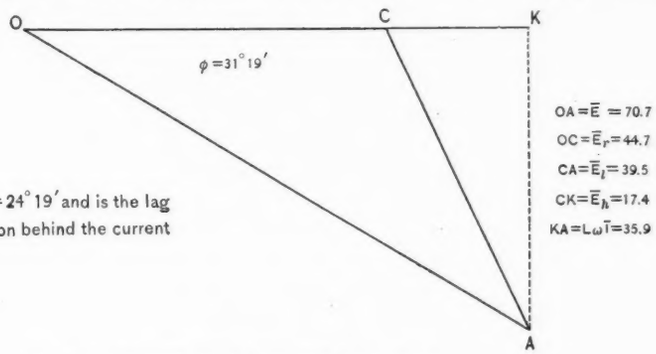

O
C
K
A
φ = 31° 19′
The angle CAK = 24° 19′ and is the lag of the magnetization behind the current
OA = Ē = 70.7
OC = Ē_r = 44.7
CA = Ē_l = 39.5
CK = Ē_h = 17.4
KA = Lω Ī = 35.9

FIG. 31.—ALTERNATING ELECTRIC MECHANISM.

TABLE II.

Degrees.	e_r	e_l	$\mathcal{B}$
0	−31.2	30.6	−8320
15	− 9.4	36.0	−6420
30	10.4	39.5	−4720
45	22.9	47.5	2490
60	31.2	55.3	0
75	36.9	59.8	3080
90	43.7	56.2	6060
105	53.0	43.5	8610
120	62.4	23.1	10300
135	67.6	3.1	10970
150	64.5	−14.5	10510
165	51.0	−23.9	9700
180	31.2	−31.2	8320

In Fig. 30 two rectangular coordinate curves are shown. The one marked ($\Phi\,i$) shows the relative variations in the magnetization and current during the time of one complete cycle. The values of the magnetization are plotted as the ordinates and the corresponding values of the current as the abscissae of this curve. Positive values of the magnetic flux are plotted above the horizontal axis and negative values below. Positive values of the current are plotted to the right and negative values to the left of the vertical axis.

The area of this curve is proportional to the *work* done in overcoming the hysteresis loss during one cycle; it is in fact a "hysteresis loop," and shows that the magnetization and the current are a maximum at the same instant.

The curve marked $\Phi'\,i'$ indicates the relative variations that take place between the equivalent magnetization and the equivalent current during successive intervals of time. It is plotted from the instantaneous values of these quantities in the same manner as in the case of the curve $\Phi\,i$.

The curve $\Phi'\,i'$ is an ellipse and has the same area as the curve $\Phi\,i$. It is therefore proportional to the work of hysteresis for one complete cycle. It further indicates that one of the chief effects of hysteresis is to introduce "harmonics" into the current curve and thus distort it. There is a slight increase in the I^2r loss due to the harmonics, but this is so small that their power effect may be disregarded entirely: they distort the power curve without changing its area.

The hysteresis power loss in the circuit is readily obtained by subtracting the I^2r loss from the mean power, and is therefore equal to,—

$$2598 - (43)^2 \times 1.04 = 749 \text{ watts.}$$

[See equations 91 and 92, and page 685.] It can also be determined by plotting the power curve obtained from the product of the instantaneous values of the apparent counter electro-motive force and the current, i. e., from ($e_l\,i$).

The [mean]^2 values of the effective electro-motive force and the apparent counter electro-motive force have been obtained by plotting their instantaneous values, as tabulated in Table II, in polar coordinates. These constructions are shown in Fig. 28, by the curves marked e_r and e_l respectively. The area enclosed by the curve e_r is 7.83 square inches, and therefore

$$\text{the [mean]}^2\, e_r = .6366 \times 7.83 \times (20)^2 = 1998 \text{ "square volts,"}$$

since the scale is 20 volts to one inch and therefore one square inch equals $(20)^2$ or 400 "square volts" in this figure. The virtual value of e_r equals,—

$$\bar{E}_r = \sqrt{1998} = 44.7.$$

The area enclosed by the curve e_l is 6.15 square inches, therefore

$$\text{the [mean]}^2\, e_l = .6366 \times 6.15 \times (20)^2 = 1566 \text{ "square volts,"}$$

and therefore

$$\bar{E}_l = \sqrt{1566} = 39.57.$$

The curves marked e_r' and e_l' are plotted from the instantaneous values of the equivalent effective electro-motive force and the equivalent counter electro-motive force; they enclose the same area as the curves e_r and e_l and are perfect circles. The virtual value of the apparent counter electro-motive force and the virtual value

of its equivalent sine curve are of course equal, since they are the virtual values of the differences of sets of curves the corresponding virtual values of which are equal.

In Fig. 31 the triangle of virtual electro-motive forces of the circuit we have been discussing has been constructed to the scale of 20 volts to the inch. On measuring the angles COA and CAK we find that they are equal to the angle of lag of the equivalent current behind the impressed electro-motive force and the angle of lag of the magnetization behind the equivalent current respectively, which evidences the fact that

If we determine the virtual values of the electro-motive forces acting in any circuit, and construct with them the triangle of electro-motive forces for the circuit, we have at hand all the data necessary for the construction of the equivalent sine curves of the circuit in their true phase positions, relatively to one another, without the aid of the instantaneous curves.

Example No. 5.

A circuit has impressed upon it an alternating electro-motive force of which the equation is,—

$$e = 1500 \sin (\omega t - 1^\circ\ 37') + 102.6 \sin (3\ \omega t - 15^\circ\ 39'),$$

and the resultant current flowing in the circuit is expressed by the equation,—

$$i = .196 \sin (\omega t - 49^\circ\ 20') + .048 \sin (3\ \omega t - 76^\circ\ 50') + .0164 \sin (5\ \omega t - 90^\circ),$$

1. How much power is expended in the circuit ?

2. And what is the lag of the equivalent current behind the equivalent impressed electro-motive force, or what is virtually the angle of lag of the current behind the electro-motive force ?

1. By equation (112) the mean power developed is equal to,—

$$P = \frac{1500 \times .196}{2} \cos (1^\circ\ 37' - 49^\circ\ 20') + \frac{102.6 \times .048}{2} \cos (15^\circ\ 39' - 76^\circ\ 50')$$

$$= 99.10 + 1.19 = 100.29 \text{ watts.}$$

2. By equation (105) the virtual or effective values of the electro-motive force and current are,—

$$E = (\overline{1500^2} + \overline{102.6^2})^{\frac{1}{2}} \times .707 = 1063 \text{ volts, and } I = (\overline{.196^2} + \overline{.048^2} + \overline{.0163^2})^{\frac{1}{2}} \times .707 = .1434 \text{ amperes,}$$

and, therefore, by equation (118),—

$$\cos \phi = 100.29 \div (1063 \times .1434) = .658 \text{ and } \phi = 48^\circ\ 50'.$$

THE STEAM TURBINE—II.

BY FRANCIS HODGKINSON.

In all engines the governor is an important consideration. A fly-ball type of governor is made use of and has several features conductive to good regulation. The ball levers are swung on knife edges in lieu of pins. The governor works both ways; that is to say, the mid-position of the levers is admitting a full head of steam to the turbine. A movement from this in either direction is tending to cut off the supply. This serves a useful purpose in the event of a very excessive load coming on the turbine, such as a short circuit, which has the effect of bringing down the speed more than the percentage variation permitted by the adjustment of the spring when the steam immediately becomes shut off. Again, in such an event as some of the governor-driving mechanism becoming broken and the governor balls slowing up

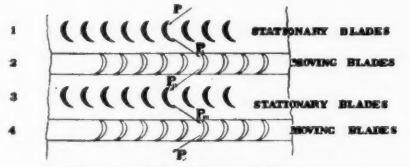


FIG. 9.—THE STEAM TURBINE.

independently of the turbine, the steam is shut off before any damage could take place.

The speed of the turbine may be varied within all the limits of the governor spring while the turbine is running. This is particularly useful in bringing alternators in synchronism and adjusting their differences of load when in multiple. This is accomplished by grasping the top knurled head, when by means of a ball-bearing shown the spring and tension nuts remain stationary. Any adjustment of the spring nuts may then be made, without in any way disturbing the running of the turbine, other than making the change that may be desired.

The arrangement of the governor levers is that they are attached to a small relay valve which controls steam below a piston which is directly connected to the main admission valve. The levers receive reciprocating motion from an eccentric, and use the governor clutch as a fulcrum. Continuous reciprocating motion is thus given to the relay valve. This is in turn transmitted to the admission valve. The function of the governor is to vary the plane of oscillation of the relay valve, which causes the admission valve to remain open for a longer or shorter period according to the position of the governor. The steam, therefore, is admitted to the turbine in puffs, which occur at constant intervals of time. The puffs are either of long or short duration, according to the load. At full load the puffs merge into an almost continuous blast. This does not mean that in the latter case there is a more complete expansion of steam than in the former, it simply means that high-pressure steam is made use of at all loads. The complete expansion of the steam is taken care of independently in the blades.

The advantages of this intermittence are threefold. The turbine is at all times using boiler pressure steam, no matter what the load may be. The admission valve is continuously in motion, and consequently gets no opportunity to get stuck.

The power to work the relay valve and overcome the inertia of the levers is transmitted through the governor clutch, hence the balls are moved in and out a very small amount at every oscillation of the levers, so that the governor levers in respect to their motion about their points of suspension are never at rest, and consequently when a change of load comes the governor does not have to overcome the friction of rest, and is always ready to go to its new position.

These features are particularly valuable. So long as a piece of mechanism is continuously working we at least know that it is in a condition to continue working and is not stuck.

There is absolutely no variation of angular velocity in the turbine, which is necessarily present in reciprocating engines, hence the value of turbines for running alternators in multiple. This can be realized when we know a 500-horse-power turbine will run 20 minutes after the throttle has been closed. This, of course, speaks well for the low friction, but is principally due to the tremendous fly-wheel effect of the shaft. All the power is transmitted rotatively—there are substantially no reciprocating parts and no vibrations, hence no costly foundations and no holding-down bolts are necessary.

Mr. Parsons made very successful use of an electrical governor which was attached to a relay valve working in exactly the same manner as just described.

One great feature of this governor is that the solenoids may be compounded so as to give constant electro-motive force at the terminals of the generator, the turbine running faster at full load than at light load to make up for copper losses in the armature. The governor may be further over-compounded to give any percentage rise, just the same as an over-compounded generator.

The essential parts of the turbine are,

of course, the blades and buckets. They are made of hard drawn material. They vary in size from one-half inch to seven inches according to where they may be used. Every row of these blades has passages of increased area, corresponding with the volume of the steam. This increase of volume is obtained by increasing the heights of the blades, and when these have reached the desired limit the diameter of the turbine is increased and the steam permitted a higher velocity that enables the blades to recommence another progression.

this respect is this turbine a combination of Bianca's wheel and Hero's engine.

Many people suppose that these blades wear under the action of steam. Experience shows that they do not. In the case, however, of a nozzle, such as has already been described, in combination with the blades, the result is very different, by reason of the tremendous velocity of the steam. The wear even then is not much when superheated steam is made use of, but with any entrained water the wear is quite rapid. In the Parsons turbine the velocities of steam never exceed 500 to

being again assembled without having the damage repaired. The result of this, however, is less serious than would be expected. At the most two or three rows are ripped out. The blades are very tough, and the first broken blades close up the passage in the succeeding guide blades and prevent the broken pieces passing and causing more damage.

In the event of such an accident the damaged blades may be removed and the machine put into service when full power can be developed, but of course at a somewhat less efficiency, according to the num-

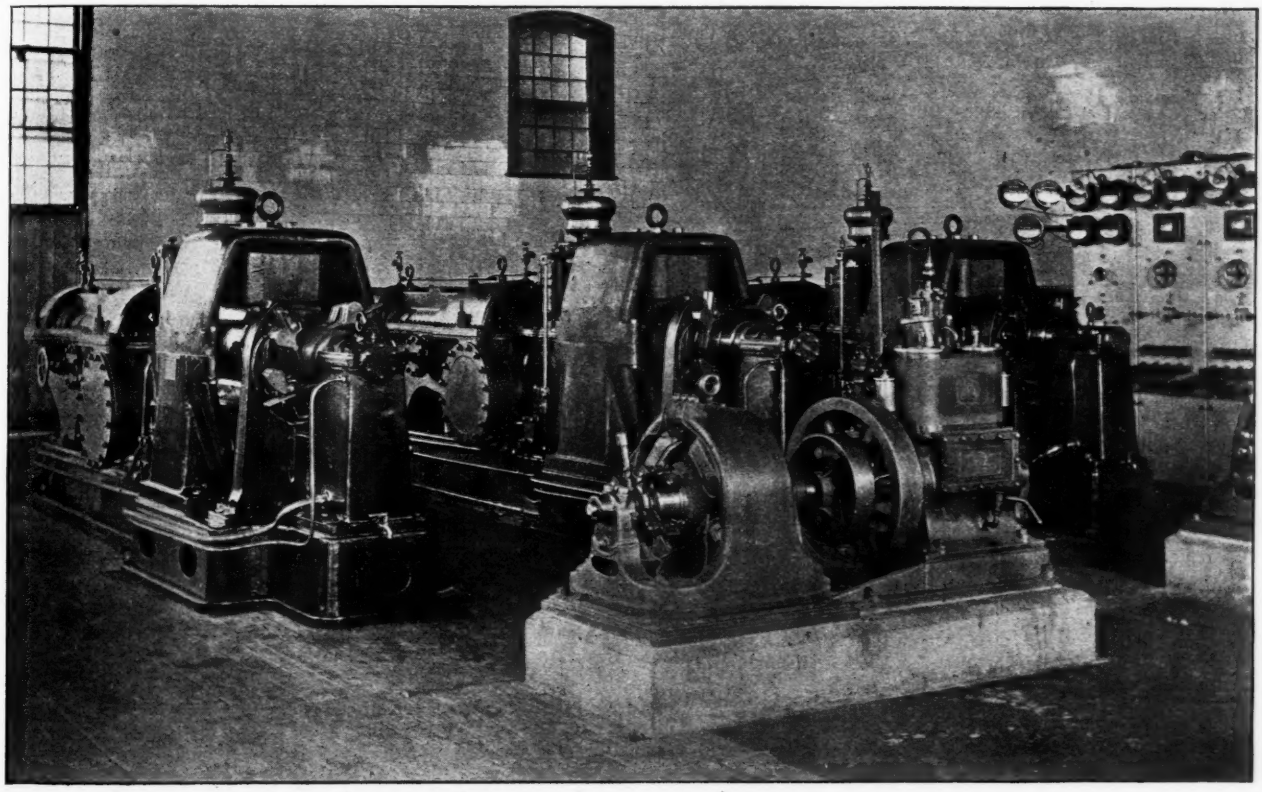


FIG. 10.—TURBINE-DYNAMO PLANT OF THE WESTINGHOUSE AIR-BRAKE COMPANY.

Considering one barrel of the turbine, the fall of pressure, or to be more exact, the coefficients of expansion, are the same for every row.

Referring to diagram, Fig. 9, the steam at pressure P in expanding through row 1 to pressure P_1 converts its energy into velocity and impinges upon the moving blades, row 2. The steam then performs a second expansion in expanding through row 2, again converting its energy into velocity, but this time the energy of the efflux is to react upon the blades from which the steam issues. The same cycle is repeated in 3 and 4, and so on until exhaust pressure is reached. The moving blades therefore receive motion from two causes, the one due to the impact of steam striking them, the other due to the reaction of the steam leaving them, and in

600 feet per second, and for the most part are considerably less than this.

The blades are secured by caulking. Experiments show that the pull necessary to pull them out is as much as the elastic limit of the material of the blades themselves. The strain to which they are subjected in practice is about one-fortieth of this amount.

Danger of the blades colliding sideways is very remote. The smallest blades have one-eighth inch clearance sideways, and the largest as much as one-half inch. These dimensions are far beyond the limits of lateral motion permitted by the balance pistons. Of course, accidents do happen to the blades, but are generally attributable to carelessness, such as the machine having been taken apart, and in handling, some of the blades damaged, the machine

ber of rows missing. The blades may be permanently repaired in a very short time by chipping out the grooves and inserting new blades. This work can be done wherever the machine may be in service, as no special machine work is necessary. Such accidents, however, are among the improbabilities.

It may be interesting to record the actual pressure exerted on individual blades in a turbine. Take, for example, one of 300-kilowatt capacity, to which special reference will be made. There are altogether 31,073 blades in the turbine, of which 16,095 are moving blades. The pressure that each of them exerts in revolving the shaft varies from .89 to 1.04 ounces.

The steam inlet is always provided with a steam strainer which is intended to pre-

vent foreign substances from getting into the turbine by means of the steam pipe. Generally such things as nuts, bolts, monkey-wrenches, etc., as have occasionally been known to come through a steam pipe, cause practically no damage, because they can not pass the first row of guide blades. The greatest inconvenience

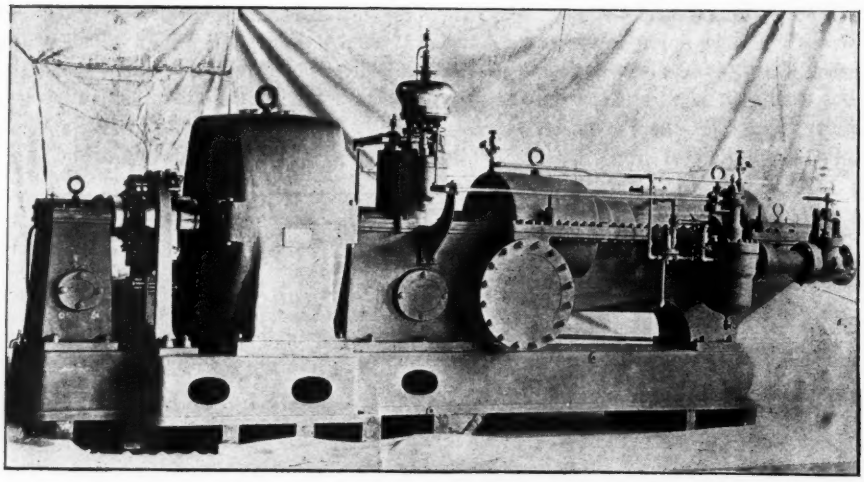


FIG. 11.—STEAM TURBINE AND GENERATOR.

of this nature is small pieces of gasket choking up the guide blade passages, which appreciably brings down the power.

As has been already stated, a jet of steam issuing through a properly constructed orifice has as much energy as the same steam performing high ratios of expansion behind a piston. In both cases the work to be theoretically abstracted from a given weight is the same; however, there are some practical reasons for expecting better results in the case of the turbine.

In the design of a three or four-stage compound-condensing reciprocating engine it is found that there is no gain in economy by expanding the steam in the low-pressure cylinder beyond a terminal pressure of about five or six pounds absolute. To do so means very much increasing the volume of the low-pressure cylinder, thus increasing the friction of the engine and the weight of the reciprocating parts. Moreover, the temperature of saturated steam, as these low pressures are reached, falls off much more rapidly, hence there are greater losses, due to condensation and reevaporation than would be gained by a more complete expansion. In the steam turbine no such limits exist. The extra volume of the low-pressure end does not add to the friction. The temperature conditions from end to end remain always the same, and hence such losses as condensation and reevaporation are not in evidence.

Turbines are constructed to utilize the energy of the steam down to the utmost limits. A condensing steam turbine, when in operation, affords a striking example of the conversion of heat into energy. The temperature of the walls of the cylinder at the high-pressure end, about 365 degrees Fahrenheit, falls in the distance of three or four feet to a temperature of about 126 degrees at the low-pressure end.

Some economy curves developed from tests made on one of the 300-kilowatt turbines now in operation at the Westinghouse Air Brake Company's works may be summarized as follows:

Full load 16.4 pounds steam per electric horse-power hour.

Three-quarters load 17 pounds steam per electric horse-power hour.

One-half load 18.2 pounds steam per electric horse-power hour.

One-quarter load 22 pounds steam per electric horse-power hour.

Running light 750 pounds per hour.

Vacuum 26 to 27 inches.

Boiler pressure 125 pounds per square inch.

Revolutions per minute 3,600.

The consumption of 16.4 pounds at full load is in itself remarkable, but such results as at the light loads have never been approached before. It may be said that the consumption at one-half load is only 10 to 12 per cent greater than at full load.

It must not be lost sight of that these results are per electrical horse-power. It is usually the custom of engine builders to publish their results per indicated horse-power, which means very little to the power user. He is chiefly interested in the economy of steam per unit of power he gets out of his power plant, not the steam per unit of power he has to put into it.

To make a comparison with a reciprocating engine and assume the efficiency of transmission from the steam cylinders to the switchboard to be 85 per cent, which is about the very highest attainable, would bring the full load water rate on the turbine just described to 14 pounds per indicated horse-power. The tests were made under ordinary conditions so far as dryness of steam is concerned, the boilers being some distance away, and no allowance made for wetness of steam.

On the curves are shown a set of lines showing the efficiency when running non-condensing. These results are somewhat

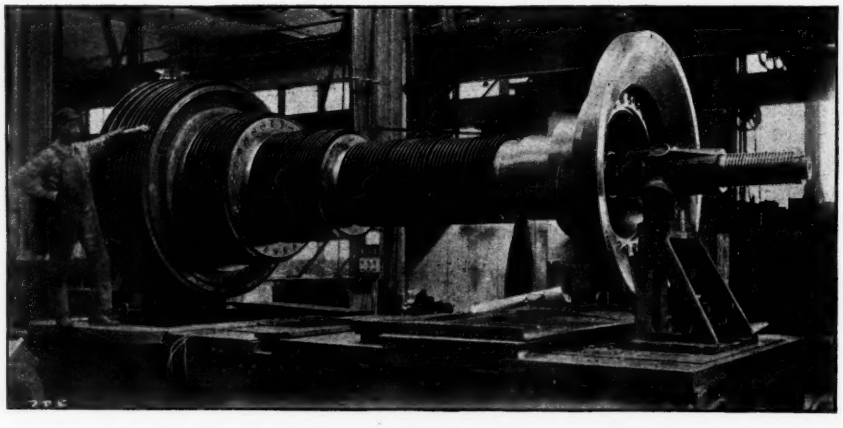


FIG. 12.—REVOLVING PART OF 3,000-HORSE-POWER STEAM TURBINE.

inferior by reason of this particular turbine being designed essentially for condensing. Nevertheless, the results are not so bad as to preclude it being operated under these conditions, should at any time the condenser be out of order. A turbine designed for running non-condensing gives proportionately as good results.

Superheating may be made use of with considerable gain in economy and without the usual difficulties. There are no internal rubbing surfaces and no packing glands to become injured by the high

temperature; 60 degrees to 70 degrees of superheat improves the economy by some 20 per cent.

In this connection Professor Thurston has lately recorded some experiments with a de Laval turbine. For every three degrees Fahrenheit of superheat one per cent of gain in economy was attained. With 37 degrees of superheat the capacity of the turbine was doubled. This gain he attributes almost entirely to the reduction of skin friction.

The practical efficiency of a turbine power plant may be gathered by some tests made by the Westinghouse Air Brake Company. After the plant had been installed some nine months the whole plant was shut down, and the steam engines which had been previously doing the work were connected up again, put in service and were kept running a week, during which time careful measurements were taken of fuel and water. After this the turbine plant was again put in operation and similar measurements made with the electrical transmission. The saving in coal averaged 35.7 per cent during the day and 36.4 per cent during the night in favor of the turbines. The saving in feed water averaged 29.8 per cent during the day and 41.4 per cent during the night. In round numbers this means a saving of 40,000 pounds of coal in 24 hours.

The gain is in a great measure due to the economy of the turbines, but also to some extent to the elimination of the condensation in long lengths of steam pipe and to the advantages of electrical transmission.

Fig. 10 shows a view of this power plant. In the foreground may be seen one of the 10-horse-power exciter engines and generators, and their size, compared with the 500-horse-power steam turbines. The whole outfit of three turbines and generators, aggregating 1,500 horse-power, occupies a floor space of 24 feet square, and allows ample room for access to the turbines.

The turbine and generator are shown separately in Fig. 11. The total weight is about 25,000 pounds; total length 19 feet; width four feet three inches.

Lately a 1,000-kilowatt outfit has been built by C. A. Parsons & Company for the Elberfeld Corporation, in Germany. At 1,200 kilowatts, 130 pounds boiler pressure, 18 degrees Fahrenheit of superheat, the turbine driving its own air pump, etc., an electrical horse-power was produced for 14.025 pounds. This is probably the highest economy ever attained in any steam engine.

Fig. 12 shows the complete revolving part of a 3,000-horse-power turbine. Its weight is 28,000 pounds; length over all 19 feet 8 inches; 12 feet 3 inches between bearings; the largest diameter six feet.

The turbine of which this forms a part is shown in Fig. 13 and is being set up in the power-house of the Hartford Electric Light Company. It is direct-connected to a 1,500-kilowatt generator, the total outfit having the following dimensions, viz.: 33 feet 3 inches long; 8 feet 9 inches wide; 175,000 pounds total weight, including generator. This is the largest steam turbine in one integral part ever built.

As there are no rubbing surfaces in the turbine no internal lubrication is necessary. This enables surface condensers to be employed and the condensed water used for boiler feed without fear of getting grease into the boilers.

The turbine is entirely automatic in all its functions, and requires remarkably little attention. The only real working part is the spindle revolving in its bearings. These bearings are found to wear but little if at all, so the cost of renewals and repairs is very small.

In 1897 the Newcastle & District Electric Lighting Company published its cost in this regard. The power-house contained 11 turbines of 75 to 150 kilowatts each. The cost for repairs and renewals amounted to .26 per cent per kilowatt per annum, and included all repairs to boilers, turbines, condensers, pumps, generators, cables, fittings, etc.

By reason of the turbine making use of the last available expansion of the steam there is considerable advantage in employing the highest vacuum. For instance, considering the 300-kilowatt turbines described and assuming the steam consumption with 27-inch vacuum to be 16.35 pounds per electrical horse-power, it may be reasoned upon a thermodynamic basis that with the same machine designed for 25-inch vacuum the consumption would be 18 pounds per electrical horse-power hour.

On the other hand, by designing the same turbine to suit an exhaust pressure of one-thirtieth of an atmosphere, or say 29-inch vacuum, the consumption would come down to 14.12 pounds per electrical horse-power hour.

The applications of steam turbines are perhaps not so universal as ordinary steam engines. They are preeminently suitable for driving electrical machinery, particularly alternating-current dynamos. Some difficulties are however experienced with the commutation of continuous-current generators of fairly large powers.

There is nothing remarkable in the de-

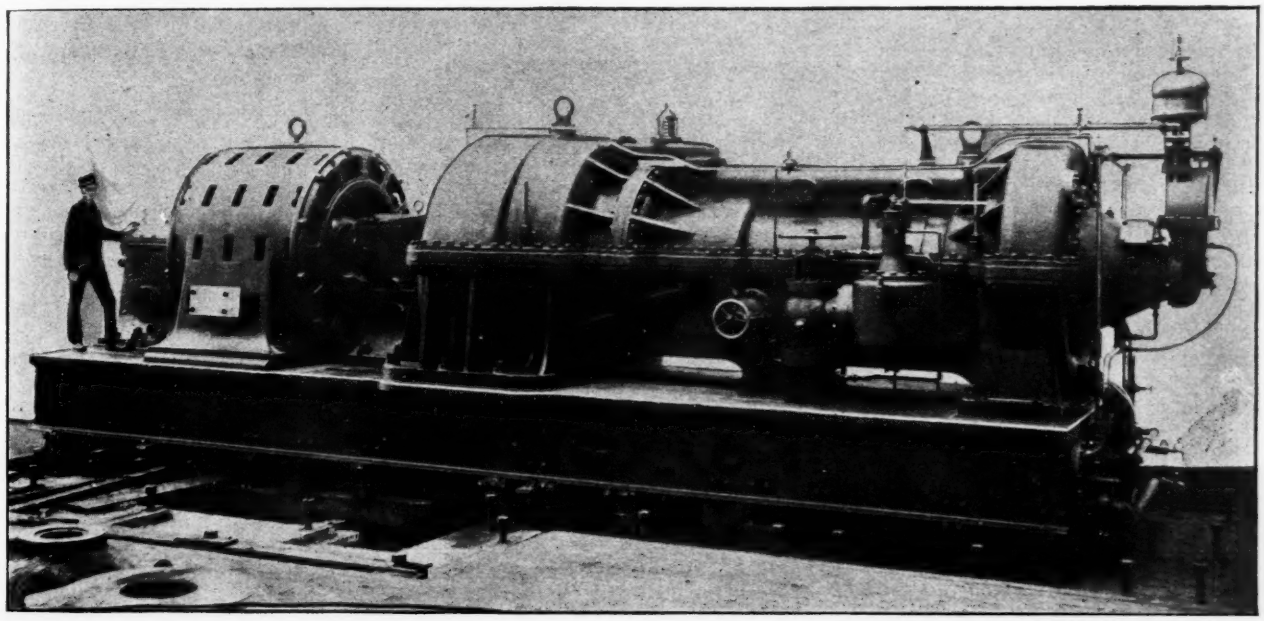


FIG. 13.—THE 3,000-HORSE-POWER TURBINE GENERATING UNIT OF THE HARTFORD ELECTRIC LIGHT COMPANY—THE LARGEST STEAM TURBINE YET BUILT.

sign of generators for this purpose except that modification necessitated by the high speed. For this reason they are remarkable for their small weight and dimensions and the absence of crowded pole pieces.

Builders of electrical machinery have for some years been working in the direction of reducing speeds from the old belt-driven rigs to admit of direct-connection to slow-going reciprocating engines. The condition for steam turbines is, however, a step in the reverse direction. Turbines have been used with good success in England for driving fans and blowers.

Although the type of bearing employed is capable of successfully dealing with about any reasonable error in balance, at the same time it is very essential that the revolving parts be very accurately balanced, in order that the collector rings and commutators may run true, and that the clearance between the tips of blades and walls of the turbine cylinder may be maintained as fine as possible, so that balancing forms quite an important stage of the construction and has many interesting features. The usual method of balancing, which consists of rolling the piece on waves and thus locating the heavy side, is sufficiently accurate for ordinary slow-speed work, but no degree of real accuracy can be attained.

Attempting to balance a body, such as the above, by such methods, might result in a heavy spot at two opposite sides and two opposite ends, which would be anything but a condition of good running balance. It is therefore found desirable to split this up into comparatively narrow rings and balance each separately, when the above error would become negligible. For balancing such rings the Westinghouse Machine Company has devised a machine which performs the work with remarkable accuracy. It is shown in Fig. 14, which shows a ring in place on the turntable. The turntable is pivoted on a beam which is in turn hung on two knife edges. Below the turntable is rigidly attached an adjustable counterweight. The turntable, of course, is free to turn independently of all this. Means are provided to slide the whole turntable and counterweight in the beam and in a direction at right angles to the line of the knife edges.

The counterweight is adjusted to bring the combined centre of gravity in a plane close to the knife edges. Then by sliding the mass in the beam the table may be made to rest horizontally. Then by giving the turntable one-half revolution the table will fall over by twice the amount it is out of balance. Readings are taken in two opposite directions and the exact location and the amount of the error may be immediately figured.

Balancing by this method may be done very rapidly and with surprising accuracy. A ring weighing 6,000 pounds has been balanced within two ounces, and rings weighing 200 or 300 pounds within one-eighth ounce.

In the case, however, of the revolving parts of electric generators the final winding, etc., are liable to throw them out of balance, and then there is no alternative but to balance them in their entirety. The shape is generally of the nature of a long cylinder with a journal at both ends. The only way then to do this balancing is to deliberately mount it on bearings which are preferably set on springs and running it up to speed by belt or any available means. While running it is marked with a colored pencil at different points which serve to indicate where to add weight.

In a small body revolving at 5,000 or more revolutions per minute the light side is always the side that comes outward, so that weight should be added just where the marks come. In some cases the marks are opposite at each end, when weight needs to be added on one side at one end and on the other side at the other end.

These facts show that when the high speeds are reached the body ceases to revolve on the geometric axis and takes the axis of gravity.

On its way up to speed there is generally some point at which there is considerable

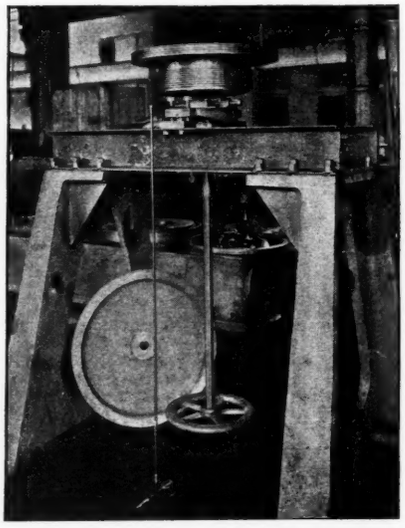


FIG. 14.—MACHINE FOR BALANCING PARTS OF STEAM TURBINES.

vibration. This is termed the critical speed and seems to come at the time when the body is changing its axis of revolution. These critical speeds become lower as the bodies are heavier and of greater radius. In the cases of heavier and bigger bodies, which also would have a lower rotative speed, the marks do not come just on the light side. They may come sometimes as much as 90 degrees ahead of the light side. The exact angle can only be found by experiment, and at best this is only a cut-and-dry method. With experience, however, work may be put in very accurate balance.

The application lately of steam turbines to marine propulsion is well known. Some particulars of the vessels equipped may be interesting.

The first vessel, named the Turbinia, was built with a view of exploring the possibilities of turbines for this purpose. It was, therefore, built as small as possible, and at the same time not so small as to preclude the attainment of high speed should the experiments turn out a success. The dimensions selected, therefore, were 100 feet long, 9 feet beam, 3 feet draught, and 44 tons displacement. It will be noted that the ratio of beam to length is unusually small—9.100 while 10.100 or 11.100 is the more usual practice for this class of boat.

To begin with, the boat was fitted with one single turbine and propeller. The result was disappointing, the chief trouble being due to "cavitations" in the propeller, resulting in excessive slip. This was verified by experiments in a tank of water subjected to vacuum. The appearance of the action of the propeller in the water was observed by looking through a slot in a disk which was made to revolve in synchronism with the propeller under observation.

It was then considered necessary to make several changes. New engines were built in three sections, the steam expanding through them in series, each section driving an independent shaft, and each shaft three propellers. Very soon 32¾ knots were attained and eventually 34½ knots at the naval review at Spithead in 1897. About 2,300 indicated horse-power were developed. The boiler, a Yarrow type with small tubes, had 1,100 square feet of heating surface and an evaporation of about 28 pounds of water per square feet heating surface at 34½-knot speed. About 600 horse-power were developed per ton of machinery and 50 horse-power per ton of total weight of vessel in full equipment. These successes resulted in a contract with the British Admiralty for a torpedo boat destroyer named the Viper. The dimensions were the same as the 30-knot destroyers of her class, 210 feet long, 21 feet beam, and 350 tons displacement. The engines consisted of two independent sets, each consisting of one high-pressure turbine driving a shaft and one low-pressure turbine driving its shaft. On the same shaft as the low pressure was permanently connected a small turbine for reversing purposes. When running ahead the reversing turbine was in connection with the condenser, so that the frictional losses due to this turbine running idle were very small. The same fact applies to the go-ahead turbines when running astern.

There were, therefore, four propeller shafts each fitted with two propellers, the one ahead having a slightly lesser pitch than the after ones.

The Yarrow type boilers have 15,000 square feet heating surface; grate surface 272 square feet; condensers have 8,000 square feet surface. The speed attained was 35 knots to begin with, and later 36.856 knots were reached.

It is generally conceded by engineers that but little more may be anticipated in the development of the reciprocating engine. Any improvement that we can imagine would not very materially improve its efficiency as a heat engine. On the other hand the turbine is capable of development in many ways, particularly in the use of superheated steam, to a degree hitherto prohibitive, so that the day may not be very far distant when the turbine will replace the reciprocating steam engine for most purposes.

ECONOMY GUARANTEES OF HIGH-SPEED SIMPLE ENGINES.*

BY E. J. ARMSTRONG.

I have been asked to read a paper upon the general subject of the economy of simple high-speed engines. I esteem this a rare privilege, and the more so because of my belief that the single valve automatic is not always given a fair chance.

The matter of economy does not always receive consideration. The engine that runs smoothly, noiselessly and punctually will have friends and purchasers whether it uses much or little steam. Mr. Armstrong had no desire to advocate improvement in economy to the detriment or neglect of other qualities which go to make up successful machines, but he believed that many engine builders had but a very imperfect idea of what their own engines were capable of. If the subject were more amenable to mathematical treatment the case would be different, but, in spite of the marvelous advancement in science at the end of the century, he believed that the exact formula for the economical performance of the steam engine has yet to be written. In view of the fact that the steam used by an engine often costs each year as much as the engine itself, it would seem as if the customer might consider steam economy as of first importance and price as a bad second. Yet even a small difference in price or a personal preference will decide a purchase without raising the question of economy at all. A difference of 10 per cent in steam consumption between two engines might easily place the more wasteful one in the position of being too expensive, even as a gift; but there is no doubt that there have been and still are even greater differences than this between engines that are sold on equal terms. It is singular that customers who figure so closely on other matters should be so careless and unbusinesslike in this, or that builders should expect to market engines with no economical record and not even a pedigree. Mr. Armstrong believed that this rather anomalous condition of things would soon be brought to an end; that for years there has been an increasing tendency among customers to raise the question of steam consumption and that builders of engines must recognize and prepare to meet a demand for definite promise and performance in the matter of economy.

This should be welcomed, not as a hardship but rather as an opportunity. It is essential to obtain more exact data concerning the performance of automatic engines, and in making efforts to improve the quality of work turned out the first step is a systematic effort at finding the defects in that work. The first move in reducing cost is to find out what things are costing, and the way to improve the economy of engines is to test them systematically and to learn their deficiencies.

It is not usually practical to test engines of small size after installation; the expense is disproportionate and the difficulties in the way of obtaining accurate results are great. The liability to error and the impossibility of running preliminary tests make it unsafe to make close guarantees to be demonstrated in this way. The proper place to test an engine is on the shop testing floor. With properly arranged apparatus tests can be made in a short time and at little cost.

Apparently a simple thing to make duty tests with apparatus of this kind, the matter is really more complicated than it seems. A detailed description of precautions necessary and the methods of detecting and locating errors, or the causes of irregular and inconsistent results—this method of testing engines can not fail to impress one with the great difference in accuracy possible when compared with the plan of testing after installation, as must be done with very large engines under any circumstances.

The manner in which different tests check up with each other is to some extent proof of their accuracy, and gives confidence in using the data obtained as a basis for future guarantees. Mr. Armstrong here presented several duty curves, plotted from tests made in the ordinary course of demonstrating economy guarantees. The majority of the series of tests shown in these diagrams had been checked by engineers representing the purchasers. In other cases reliance had been placed on the builder to see that his guarantees were fulfilled. The rate of water consumption was plotted without correction for dry steam, for which, however, a proper allowance was made. Mr. Armstrong stated that these results were not at all exceptional, as was proven by the fact that they practically duplicated each other. They show what he believed to be readily obtainable in regular practice with fairly tight valves, moderate clearance and other conditions as he described. There were other details which contributed to the results. These have to be learned by practice and can be learned at all only by frequent tests.

Mr. Armstrong believed that the single-valve engine was capable of giving results even better than those shown on the diagrams to the extent of one or perhaps one and one-half pounds per hour. At the same time he considered the results very much better than the average of high-speed work. Mr. Armstrong spent some time in analyzing the difference between the duty curves shown and the various factors which entered into the problem. As the result of these and other tests made by him he was able to approximate very closely the difference in economy which may be expected from a change in steam pressure, from a change in back pressure, from an increase or deduction in speed. It was possible also to speak with considerable accuracy of the difference in economy between a large and a small engine of the same general design or of the difference in the same engine when carrying a greater or smaller percentage of its load.

In estimating the steam consumption of an engine of a size or under conditions which have not yet been tested, there were two ways of figuring; one was to determine the losses in the engines separately from the steam accounted for by the card. This method while quite complicated is the more accurate of the two and is sometimes very valuable in working out a close guarantee. The other plan is simply to learn the general effect of the different conditions which effect economy and to use some previous tests as a basis.

With this idea in mind Mr. Armstrong named some figures representing the difference in economy which might be expected between an engine of 50 horse-power and 100 horse-power, the other conditions being the same. He also stated the difference in economy resulting from a difference in clearance of a given percentage, the difference which he had found to result from certain given variations in back pressure or in steam pressure. Other suggestions and figures as the result of Mr. Armstrong's experience and the data sheets which he submitted followed. Mr. Armstrong added that the building up of a better reputation for automatic engines was well worth the attention of its manufacturers. No guarantee of economy should be given unless its fulfillment by actual trial is provided for. Where there is no certainty that a test will be made, there is the temptation to give a lower water rate than would be the case were its fulfillment one of the conditions, especially if accompanied by penalties for failure to meet the terms of contract.

This question of penalties although considered quite onerous by engine builders, but if not provided in the contract, the only penalty is the non-acceptance of the

* Abstract of a paper read at the Steam Engine Builders' Association Meeting.

engine; and as this is often impracticable because of lack of time, there is a good chance that the guarantee is not worth anything. Definite penalties at least have the effect of protecting those who really make their guarantees in good faith and with a knowledge of what they can do. There is nothing wrong about it from the purchaser's standpoint. A deficiency in economical performance means a direct and continuous loss to him.

There is one feature of the situation that is manifestly unfair and calls for remedial action. Better economy costs money. It may not actually cost more to build the high-duty engine than a wasteful one, but it costs a good deal more to learn how and to keep up the standard afterward. It costs money to tune an engine up to meet a close guarantee, and testing engines is an expensive business at the best. There should certainly be an addition to the price when guarantees are required. Mr. Armstrong suggested that all duty guarantees should provide for their fulfillment on the shop floor tests before shipment and should always be considered as an extra, it being optional in all cases with the purchaser to accept the proposal with or without the guarantee. If the guarantee does not mean anything, it should not be made. If it does stand for something, it costs a good deal and is worth to the customer all that he is likely to be asked for it.

Congressional Roll-Calls and Voting by Electricity.

A novel plan which is said to be the result of considerable labor on the part of Representative Otey, of Virginia, is to be submitted to the house for its possible adoption. Mr. Otey wishes to expedite roll-calls in Congress and has invented a machine worked by electricity for that purpose. His idea is to have a board placed directly at the rear of the speaker's desk and in front of the main entrance such electrical apparatus connected with each member's desk by wiring as would enable him to touch a button and display his vote, aye or no, by means of incandescent lights placed opposite to his name on the board. This would enable the entire house to see exactly what the members were doing, the clerks could figure up the totals in a very short time, and there would be no delay in getting an expression of sentiment on any subject from the congressmen. At the present time the yea and nay method of voting occupies about three-quarters of an hour, putting the members in a bad humor if they are in a hurry to get the business of the day finished.

Views, News and Interviews

The story runs that an Irishman named Murphy, who kept a livery stable, suddenly ran out of hay, and calling up his friend Ivins, over the telephone, the following conversation took place:

"Is dhot Oivins?"

"Well?"

"Oi want tin tons of hay."

"Who's it for?"

"Fer the harrse, ye ———!"

A southern paper tells a story of a Chattanooga merchant who installed a telephone near the front door of his shop and one morning stepped up to the transmitter to answer a call. Just at that moment a North Georgia farmer who had never seen a telephone before came into the place and inquired, "Wanter buy any aigs?" The merchant, who was intent upon getting his message, gazed abstractedly at the farmer and told the telephone, "I can't hear you!" "Wanter buy any aigs?" shouted the farmer in a voice that made the windows rattle. Still unable to hear the man who was calling him, the merchant again remarked, this time without looking at the farmer, "I can't hear you! Speak louder!" For the third time the farmer spoke, roaring out his previous question so loud that people several blocks away stopped and asked what the trouble was. This had the desired effect. The merchant left the telephone, forgetting his call, and turning savagely on the intruder, remarked "No! damn it, I don't want any eggs!" The farmer smiled, and as he went out was heard to remark softly, "I never did see one o' them deef fellers, but whut I could make 'em hear if I only let myself out."

Number three shaft of the Tamarack mine, which has been worked night and day since August, 1895, and which with its machinery and equipments has cost millions of dollars, has at last been successfully concluded at an approximate depth of 4,760 feet, touching a conglomerate lode. The successful bottoming of this shaft adds from five to ten million dollars to the value of the mine.

In a recent issue the *Telephone Magazine* states that "the National Telephone Company, of London, England, has notified its subscribers of an intimation from the post-office that a minimum of 20 minutes must always elapse before any reply can be expected by a subscriber as to whether he can get through to the town on the trunk service with which he wishes to communicate. The delay is attributed to an insufficiency of trunk lines and a paucity of operators, but wouldn't that excuse in the American exchange 'hang you up?'"

Meeting of the Interstate Telephone Association in Kansas City.

The Interstate Telephone Association is to hold its next meeting at the Hotel Baltimore, in Kansas City, Mo., on Tuesday, January 15, 1901, and every owner or representative of telephone interests is urgently requested by the officials of the organization to attend. The notices sent out by the secretary, Mr. George R. Armstrong, state that he looks for the largest gathering of local telephone interests which has ever been held in the West.

New Electromobile Storage Battery.

Referring to the announcement in a recent issue of the ELECTRICAL REVIEW that the American Bicycle Company had purchased the patents on a new electromobile storage battery, invented by Mr. Elmer A. Sperry, it is now learned that all the automobile patents, machinery and tools of the automobile department of the Cleveland Machine Screw Company, for which Mr. Sperry has been the electrical engineer, have been purchased outright by the American Bicycle Company. The Cleveland Machine Screw Company is now engaged in extensive preparations to build electromobiles and batteries on a large scale.

A Million-Dollar Electric Plant.

Plans and specifications for the new power station of the Seattle, Wash., Electric Company call for an expenditure of approximately $1,000,000, and have been received in that city from Boston architects. In many respects the work of constructing the plant will be unique in local building circles as the foundation of the building will be made by driving 3,000 piles deep into the soft earth and surmounting them with eight feet of solid concrete. The station itself will be built of steel, brick and stone with as little wood as possible, the entire weight of the steel used in the frames and columns reaching a total of something like a thousand tons. Two very large engines will generate electric power being direct-connected with generators developing sufficient energy to run over 100 miles of electric street railway. In the third story of the building the boilers will be placed, the furnaces for which will be fed with coal through electric conveyors with automatic stokers. According to the terms of the contract the building must be finished during the ensuing year and the company has announced its intention of immediately soliciting bids.

THE CONSTRUCTION OF SMALL TELEPHONE EXCHANGES.

BY A. E. DOBBS.

In laying out a new telephone exchange there are a number of things to be considered beside the first cost of the plant. Whether the concern shall be a mutual stock company, or one owned by a few individuals are quite important questions.

A mutual stock company, which in some cases is carried to the extent of making every subscriber a stockholder, with one vote, will insure the active support of every one of them, but it also involves the disadvantage of having a large board of directors to deal with and in some cases much needed improvements will have to be foregone in order to please some kicking member of the board who is over-conscientious in the matter of putting out the stockholders' money. The first thing to be done after organizing is to get a franchise, which is not always a matter of form.

There are councilmen so constituted that the very idea of a new telephone company will impress them with the gravity of their positions, and there will be all kinds of questions raised as to the legality of their acts; straggling villages will all at once put on metropolitan airs, and demand underground construction, and anywhere from two per cent to five per cent of the receipts. Of course, you must take what you can get, but there are some things to be contended for in the argument before the city council.

First, oppose, as far as possible, any condition that the other company or companies are not compelled to perform. Second, oppose all resolutions requiring underground work, unless conditions are such that it would be good engineering to do so. Most towns require several free telephones, the use of one or more pins; in some cases, the entire top arm, and other minor restrictions.

The following franchise granted within the last 60 days, while not a very good one for the telephone company, is a very fair average of what might be expected in some towns. There are several clauses to which exceptions might be taken, clause X being particularly objectionable.

While it might be a very good thing in some instances for different companies to combine in the building one good pole line, yet it almost invariably makes trouble sooner or later. It is also fair to assume that the older company in that town does not give the city even one free telephone, to say nothing of six, with reduced charges on all the rest the city may need. The conditions are not onerous, and will probably never be enforced to the letter, but one or two aggressive councilmen could make a great deal of trouble, though if well managed, public opinion will generally be with the new company. If, for example, the council should take a notion to order the wires underground the new company could be compelled to obey the ordinance, while the chances are the older company would do as they pleased about it.

The following is a verbatim copy of a franchise granted within the last 60 days and represents a very fair one for the average town:

The Common Council of the City of ———— do Enact as Follows:

SECTION I.

That ——, ——, ——, —— and their associates, hereafter to be incorporated under the name of the ———— Telephone Company, be and are hereby authorized and empowered to use and occupy the streets and alleys of the City of ————, as hereinafter specified, for the purpose of erecting poles and stringing wires and constructing subways with manholes in connection with the building and maintaining of a telephone system, and to maintain and operate such system when so constructed.

SECTION II.

The said company shall construct its lines with the necessary appliances to maintain and operate the same in the streets and alleys of the said city as herein specified at its own expense and in conformity with the ordinances, resolutions and regulations of said city now in force, and which may be hereafter enacted or adopted, and with due and proper regard for the welfare of the city and of the streets and alleys used and occupied, and of the trees thereon.

SECTION III.

All work done pursuant to the franchise hereby granted, shall be done under the supervision and to the satisfaction of the street committee of said city, and under the direction of the proper authorities of said city, concerning the location of poles, cross-arms, wires and other appliances.

Poles to be erected by said company shall be under the direction of the street committee, and to be of such kind and character and placed at such points as may be approved by them and shall be painted under the direction of the street committee if required by the common council.

Said company, its successors or assigns, shall file with the street commissioner of said city, whenever required, a map showing the location of its poles, wires, cross-arms and such other appliances as may be used by it under and by virtue of this franchise.

SECTION IV.

Said company, in consideration of the franchise hereby granted, shall provide and maintain on poles, cross-arms and lines, erected pursuant to this permission, necessary and satisfactory space, free of charge, cost and rental, to carry the wires now or hereafter owned by the City of ————, and the agents and employees of said City of ———— shall at all times be allowed to place and repair such wires, and such wires shall not be cut, changed or removed by said company, or any of its agents or employees, except upon written notice of at least four hours to the chief of the fire department, or the superintendent of the fire telegraph, of the city, and then only for the purpose of changing and replacing its poles or lines, or repairing the same.

SECTION V.

The franchise hereby granted shall not be considered as depriving the City of ———— from granting a similar one to any other person, firm or corporation, and the said city shall have at any time the right to compel, on reasonable notice, the said company, its successors or assigns, to place its wires in conduits in any of the streets or alleys of the said city, and to remove its poles and overhead lines from any and all such streets and alleys in said city.

SECTION VI.

It is also made a condition for the granting of this franchise that said company shall furnish to the City of ————, and to its subscribers, a good and sufficient telephone service, and that said company, its successors or assigns shall not ask, charge, demand or collect from any of the subscribers in said city for standard telephone service more than the following rates, to wit:

Not to exceed thirty ($30) dollars per annum for business telephone service on single metallic circuit, or twenty ($20) dollars for residences.

As a further condition for the granting of the franchise the said company, its successors or assigns, shall furnish the said city, to be placed as directed by the common council of said city and the same to be connected with the central exchange. If changed after once placed, expense of such change to be paid by the city. The said company shall furnish to the city departments of ————, for municipal service, additional telephones as directed by the common council at one-half the standard rates in said city for similar service.

SECTION VII.

Said company, its successors in office, or assigns, shall not sell the franchise hereby granted to any telegraph or telephone company, in whole or in part, or consolidate with any company who are in existence, or may hereafter be organized or incorporated, without first having obtained the consent of the common council to do so.

SECTION VIII.

Said company also agrees to make connections between all polling places in the several wards of the city and the City Hall on the occasion of all Fall and Spring elections held in the city without charge to the city.

SECTION IX.

This franchise and all rights thereunder shall terminate at the expiration of thirty (30) years from the date of its granting.

SECTION X.

In case another franchise shall hereafter be granted by the common council of this city to any other company or companies, to construct, operate and maintain a telegraph or telephone system or systems in said city, the said ———— Telephone Company shall permit such company or companies to use its poles for carrying all cables that in its or their service, and all costs and expenses of construction, maintenance and operation of the same, shall be pro-rated equally among said companies.

SECTION XI.

A failure on the part of said company, its successors or assigns, to fully comply with, and carry out, each and every one of the terms and conditions of this franchise, renders the same and all rights and privileges thereunder void, and the same shall be thereby forfeited.

This ordinance shall be published once in the ———— and once in the ———— and shall take effect upon the filing and approval of the bond herein provided for.

SECTION XII.

The said ———— Telephone Company shall file with the city clerk within thirty days after the passage of this ordinance or grant, an acceptance in writing of the privileges hereby granted, signed by the president and secretary of the said company under the authority of its board of directors. And before any work is done under this franchise, the said company shall file with the city clerk a good and sufficient bond executed by a surety company to be approved by the mayor, in the sum of two thousand ($2,000) dollars, that they, the said company, shall on or before the first

day of February, 1901, begin, in good faith, operations for the construction of a telephone system, and shall have the same completed and in operation on or before the first day of August, 1901, and said bond shall provide that said company shall well and truly, save, keep and bear harmless and indemnify the City of ———— from all costs, suits or action that may be brought, or judgments and executions that may be had at any time against said City of ———— by reason of any neglect or wrongful act or omission of the said telephone company, its servants or agents, in the construction or maintenance of said telephone system.

Sun Spots, Magnetic Storms, Comets Tails, Atmospheric Electricity and Aurorae.

The subjoined communication from Dr. Oliver Lodge appears in a recent issue of the London *Electrician:*

The whole subject of electricity demands reconsideration in the light of the facts now known concerning the existence of electrons, or at least of negatively charged corpuscles smaller than atoms. The old facts and theories remain true, but a further step can be taken; and a glorified electrostatics, that once despised subject, seems likely to dominate the field. It has long seemed to many persons extremely improbable that magnetic disturbances on the earth are caused by direct magnetic moment at the sun. It has likewise seemed to several persons improbable that such disturbances are caused merely by ethereal or electromagnetic waves emanating from the sun and traveling with the speed of light. Such waves exist no doubt, but there is no reason to postulate for them a magnetic influence. The assumption that every solar influence on the earth (except gravitation) must be due to the agency of Maxwell's and Hertz's waves may turn out to be only another instance of the usual human tendency to overwork any successful theory, and to press a good nag into too great a variety of service. At one time (the reign of chemistry) everything in physics was attributed to some imponderable form of matter: later (under the influence of Tyndall and others) everything was considered to be due to some mode of molecular motion; now everything is popularly supposed to be done by waves. A little time hence (though it is always rash to predict) I suggest that electrons or charged corpuscles will be the central feature of physical science, and that some people (I among others, no doubt) will be engaged in pressing them into all manner of service, and clogging up keyholes by trying to unlock doors with them that they will not really open. Later on still, this will be recognized, and our successors will be attracted by some other real and inspiring novelty; but meanwhile the electron theory will have had its day, and, like that of molecular vibration and of ether waves, each in its own time, will by no means cease to be, but will merely be relegated to its proper place in the cosmos. It is only a few paradoxers who assume that every fresh step means the overthrow and abandonment of former ones.

The attempt thus to explain as many phenomena as possible in terms of the most recently discovered fact is perfectly legitimate and necessary; for the quickest way of finding out what doors can be opened by a particular key is to try it, not too roughly, in their locks.

Very well then: with this caution I would call attention to the facts: (1) That the observed phenomena of comets tails have long suggested to observers and theorists the existence of a strong repulsive force, probably electric, acting on small particles in the neighborhood of the (presumably electrified) sun; (2) that the occasional, though perhaps fanciful, "aiming" of a sunspot disturbance at the earth has suggested to G. F. FitzGerald the notion that magnetic disturbances might be due to something in the nature of a projectile, a torrent or flying cloud of charged atoms or ions projected past or near the earth and thereby affecting terrestrial compass needles. But on working out the arithmetic of this hypothesis it appeared that the speed and charge necessary were such as to be improbable for atoms of matter to possess, on any reasonable hypothesis of projection.

I have not FitzGerald' ideas clearly in memory, and I may be doing them injustice; but it will be seen that this is not my intention. My attention rather is to call attention to them as containing a possible clue to, or link between, many apparently distinct phenomena, if for ions or charged atoms we substitute the idea of electrons or charged corpuscles (whatever they may be—disembodied charges, perhaps, the existence of which is now well known under the name of cathode rays in a Crookes's vacuum tube, and by the name of Lenard rays outside in the atmosphere.

To those who remember the high velocity measured for such particles—not incomparably less than that of light; to those who recognize the truth of J. J. Thomson's proof that their material mass is exceedingly small in proportion to their electric charge; to those who realize the extreme ease with which they are detachable from a negatively charged body under the action of ultra-violet light and by other methods, it will seem no straining after hypothesis to suggest that such electrons may be flung off the sun; or, if they are scattered like meteors about space, that they are repelled by it, if it be a negatively charged body, as the cathode ray constituents are repelled by a cathode, describing therefore not elliptic but hyperbolic orbits. If so, then in their flight past the earth they must act as an electric current, and therefore, unless they always surround it quite symmetrically, must occasionally deflect its magnetic needles. Furthermore, if they impinge on its atmosphere, they may electrify it.*

And as they graze past the polar regions —for it will be the polar regions they will constantly graze if they come from the sun—they may in passing through the atmosphere give rise to the appearance not of a shower of meteors but of the boreal and austral auroræ.

The name of Crémieu will here rise to the mind as that of the experimenter who has thrown doubt on the foundations of electromagnetism, as laid by Maxwell and others, by performing an experiment which appears to contravene the hitherto admitted law that a moving electric charge is a full-blown and perfect electric current. Whereas my own view (*quantum valeat*) is that in all probability no other kind of electric current exists.

If any one in this country shares in the qualms apparently excited in France by these experiments of Crémieu—which experiments, however, are interesting enough and require explanation (I sincerely hope that he has not found a mare's nest built upon an arithmetical error)—I say if any one in this country allows himself to doubt the magnetic power of a moving electric charge, let him take a horseshoe magnet and that well-known cylindrical form of Crookes's tube which has a strip of phosphorescent mica along its axis, and refresh himself by employing the magnet to deflect the cathode rays.

To make the experiment more complete, the tube or the magnet should be mounted so as to be capable of bodily motion, and an attempt be made to observe the reaction, which it is to be supposed will be found acting upon the magnet, and not, as in the case of the radiometer, upon the glass.

OLIVER LODGE.

University of Birmingham, December 1, 1900.

* This is not for a moment to be supposed to be the *only* source of atmospheric electricity; there are many *veræ causæ*; but it may be a disturbance of it. And as the earth is constantly sweeping up meteors in its pilgrimage through space, so perhaps it may be sweeping up stray electrons, especially if it be itself positively charged. It may be, however, that no stray electrons can exist near a negatively charged solar system, but are accumulating elsewhere.

NOTES ON LIGHT.

BY WILLIAM ROLLINS.

NOTE CXIII—THE VACUUM IN AN X-LIGHT TUBE.

That the vacuum in an X-light tube must be in the neighborhood of a millionth of an atmosphere is a fetich worshipped too long. That the "dark space" must fill the tube before X-light can be produced is an error.

That a free path—the so-called "free molecular path"—is required is absurd. There is no proof of the existence of such a path. It is not the vacuum that determines the fitness of a tube. It is the conditions of the terminals and the generator. If you use energy enough you can rush the cathode stream units through a tube at atmospheric pressure, producing brilliant X-light. I have stated this repeatedly in different ways in earlier notes, though evidently not in sufficiently incisive English, for manufacturers continue to supply physicians with apparatus constructed on incorrect principles, requiring great care and skill to operate. The greatest attention must be paid to the condition of the tube; the resulting light is not powerful enough; its quality is such that it does not markedly differentiate tissues; no attempts are made to overcome the great diffusion of the light into the room; no selective filters are used to strain out these vibrations whose period causes them to suffer diffusion in the tissues, thus blurring the image of deep-seated tissues. All this delays the general introduction of the Lenard-Roentgen light as a daily aid to the physician. I hoped by publishing this series of short notes to make the continuation of this state of things impossible, but the time used in writing out the results of my experiments and making the illustrations would have been better employed in some other way, as I have not achieved this result, though I have stated the principles on which efficient apparatus can be constructed, built the apparatus, and proved its value.

November 11, 1900.

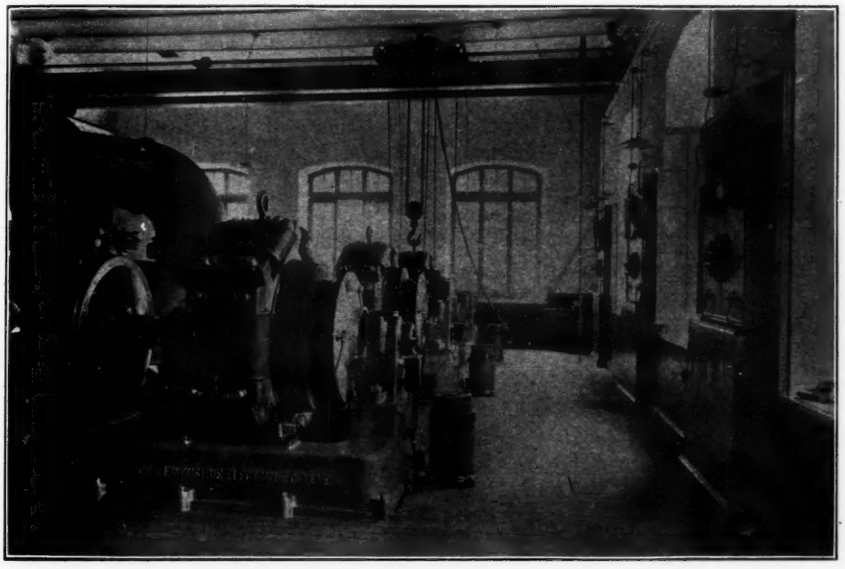


FIG. 1.—THE GENERATING STATION OF THE RENTURIA DIRECT-CURRENT POWER TRANSMISSION INSTALLATION.

American Institute of Electrical Engineers.

By direction of the committee on papers and meetings the one hundred and forty-ninth meeting of the Institute has been postponed to Wednesday, January 9, 1901, when it will be held in connection with the Institute dinner at Muschenheim's restaurant, 41 West Thirty-first street, New York city, at seven o'clock P. M. The topic for discussion after dinner will be "Electricity in the Last Century and in This." Several eminent members of the Institute will speak upon this subject. The price fixed for the dinner is $2.50 per cover. Applications for membership from eleven candidates will be acted upon January 25, 1901.

In 1866 the consumption of aluminum in the United States was roughly figured at about one and a half tons at a net cost of $3.95 a pound; while in 1899 the consumption exceeded 5,000 tons, the price having fallen to 26 cents. Figures for the production and consumption of this metal for 1900 have not as yet been fully compiled but it is estimated that they will reach something over 12,500 tons, a considerable quantity of this being exported.

POWER TRANSMISSION PLANT AT RENTURIA, SPAIN.

BY FRANK C. PERKINS.

It is particularly interesting to note the details of a continuous-current high-tension power transmission plant, particularly at this time when polyphase alternating currents are so largely used in this field of work.

A steam plant was replaced at the paper works of the Societé Vasco Belga, at Renturia, near San Sebastian, Spain, by electrical power. A high-tension power transmission plant was installed, receiving its power from a stream some 14 kilometres from the works.

The electrical generators at the power-house, Fig. 1, consist of three groups of direct-connected turbines and dynamos. Each unit was designed to supply current to the extent of 250 horse-power. This machinery was installed by the Compagnie de L'Industrie Électrique, of Geneva, Switzerland, and was designed on the system of M. Thury.

The generators are direct-current machines for series operation and supply a constant current of 65 amperes, with a varying potential, the maximum being 5,200 volts. A second power-house is to be installed about one kilometre further away. This plant will have a capacity of 1,500 horse-power, and will supply two transmission lines, operating with a potential of 10,000 volts.

The line is calculated to have a loss of 6.4 per cent. or a total drop of 640 volts, the current being held constant at 65 amperes. This transmission line will traverse the range of the Pyrenees mountains as far as Renturia, a distance of 13,500 metres. The present receiving station at Renturia includes six series direct-current motors, shown in Fig. 2. Two of these machines have a capacity of 130 horse-power each and are used for general power distribution; two 50-horse-power motors are utilized for operating paper-making machinery. A 50-horse-power Thury motor is used on the paper-pressing machines, and a 60-horse-power machine operates the tools in the repair shops of the paper mill.

It is claimed that the series direct-current system adopted was decided upon on account of the special advantages it presented for the operation of paper-making machinery. Perfectly constant speed is guaranteed and at certain times, when it is found necessary, the speed can be changed according to the needs of this line of manufacture.

Each generator is supplied with a sep-

arate switchboard upon which is mounted the various measuring instruments, switches and apparatus for its control. The direct-current high-tension motors have special regulators mounted upon the top of each machine and the bases are carefully insulated from the floor and foundations by being mounted on porcelain insulators.

The high-tension direct-current system necessitates in many cases the use of motor generators for reducing the voltage to a proper working potential. These motor-generators (Fig. 3) consist of a high-tension constant-current motor mounted in the centre, and on each side is directly connected by a flexible coupling a direct-current dynamo. All of the motors are connected in series and the voltage varies as the motors are switched on or off and the load is varied in the line.

At Genoa, Italy, a high-tension direct-current system has been in successful operation for a number of years. In that installation several stations are operated, all of the generators working in series and producing a line potential of more than 8,000 volts.

Except in special cases where it is absolutely essential that direct current be supplied to the consumer, it is undoubtedly the more practical method to utilize polyphase currents for this class of power transmission work. Even when a direct current is necessary rotary converters are now so successfully and extensively used for transforming polyphase alternating currents to direct currents that there is little to be gained by operating directly with continuous currents with their troublesome commutators and unattractive methods of transformation from high to low potentials.

A bequest of $20,000 is contained in the will of the late Professor Hughes (inventor of the microphone and other electrical instruments) to the Royal Society, of England, the bequest specifying that the income be given annually as a prize either in money or a medal for original discoveries in physical sciences. The society has finally decided to award a gold medal annually, to be called the Hughes medal, not exceeding $100 in value, together with the balance of the income, to the most worthy recipient without restriction of sex or nationality, for original discovery in the physical sciences, particularly electricity and magnetism.

Electricity is to interfere with another industry. It is said that owing to the introduction of electricity for the manufacture of cigars, cigarettes and tobacco several thousand hands will soon be thrown out of work.—Concord, N. H., *Monitor*.

Electrical Industries in Bangkok, Siam.

The development of the electrical industries in Bangkok presents some interesting features to the trade just now, writes Consul-General Hamilton King. The Bangkok Tramways Company, Limited, received from the government in 1887 a concession for a street railway. This line was built in 1889 for horse cars, and changed to an electric-trolley system in 1892. It is six miles in length, and has been doing a constantly increasing business and paying well from the start.

The city of Bangkok is at present lighted from an incandescent central lighting station. This plant was purchased in Great Britain in 1890 by a Siamese company for the purpose of lighting the King's palace and for the use of the public. It was not operated, however, until 1894, as the company met financial difficulties. In 1897 the plant was turned over to the Bangkok Electric Light Syndicate, which had a 20 years' exclusive franchise to furnish lights for the government and for the public; again, in January, 1899, it changed owners, going into the hands of what is at present known as the Siam Electricity Company. From the time this plant was turned over to the Bangkok Electric Light Syndicate, it has been operated well and has proved a fairly paying investment.

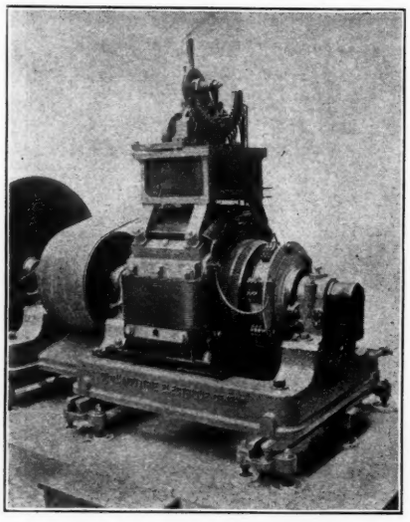


FIG. 2.—ONE OF THE CONSTANT-CURRENT MOTORS—SHOWING REGULATOR AND BASE INSULATION.

The present company has increased its capacity from 10,000 to 17,000 lamps, and has installed at the present time over 10,000 lamps. The second annual report of the directors to the shareholders shows a dividend at the rate of four per cent for the half year.

Perhaps the most interesting feature just now is the fact that the Bangkok Tramways Company, Limited, and the Siam Electricity Company are being consolidated under the name of the latter. This new company has just secured a concession from the government to build five and one-half miles of street railway line through the most promising portion of the city of Bangkok. Thus it will be seen that the Siam Electricity Company now not only controls the concessions for lighting the entire city, but such concessions as have thus far been granted by the government for building street railways. The capital of this company will be about $500,000, gold

Orders for the supplies have already been placed, and it is expected that the road will be in operation by the end of next year.

Before consolidation, the light company furnished power only during the night, but since that time it is advertising electric power for both night and day use. This will probably be taken advantage of by many of the smaller manufacturing interests of the city and may in itself create quite a demand for electric supplies. In connection with this it may be mentioned that the directors of the company have under contemplation the introduction of electric automobiles, to which they propose to furnish power. Few cities are better adapted to the use of automobiles than is Bangkok. The streets are absolutely level, and the pavement, which now covers many miles, is being rapidly extended in all directions.

Besides this company, there are 13 private electric plants installed in the rice mills of the city; two of the forts have their own plants; five ships of the navy are lighted by electricity; the navy-yard is supplied with five or six portable dynamos, and a large installation is owned by the Bangkok Dock Company.

Another company is just now endeavoring to get a concession from the government to build a street railway on the other side of the river.

The city of Bangkok lies on both sides of the Menam. This river is quite wide and has a tidal variation of from 6 to 11 feet. The current varies from that of a calm stream to the treacherous torrent of the high-water season. Water-craft of every description abound—from the ocean steamer to the little ferry-boat of the native. There is no connection between the two parts of the city, and, as a result, that portion lying on the left bank of the river has enjoyed all the modern improve-

ments, while that on the right bank has been neglected. This condition of affairs, however, must soon change, for the new railway, which runs south to Petchaburee and will be completed within a year or two, will extend through that portion of the city on the right bank of the river, and must cross the stream to find access to the present mercantile city, either by a bridge or by a closely connecting ferry.

All these developments in electrical lines have taken place during the last 10 years, yet the growth to-day is far more rapid than ever before. The three companies that import electric supplies report that their business has more than doubled during the last 12 months, while to my personal knowledge their orders during the last two months have exceeded those of any 12 previous months. There is a large and rapidly increasing business along this line in Bangkok, and there is no reason why the United States should not get a generous share. The tendency is toward the American market. The orders for the entire supplies for the new tramway during the last two months have been placed in the United States, with the exception of the rails. The order for the rails went to England, because the company thought they were unable to secure the peculiar kind they wished in any other country. This, however, I believe, is largely due to want of information on the subject, a cause which more familiar acquaintance with our manufactures will no doubt set aside. Again, a large quantity of the American electrical goods used here comes through London and European houses. This is another obstacle that can be removed by our manufacturers placing themselves in direct communication with importers here. American goods are in favor, and the prices suit. The importers complain of American lack of promptness in attention to business. While goods are delivered here in three months from the time they are ordered from Europe and England, seven or eight months, and sometimes more, are consumed in getting them from the United States. This delay should be remedied. It is within my knowledge that answers to important cables have been delayed a full month.

I quote from a letter just received at this office from one of the leading importers of this city:

My experience in doing business with the United States for the last 10 years is that, generally, in the United States you get for the same money a better article than in most European countries; but, with few exceptions, American firms are not prepared for business with distant countries. Some of them have not even a cable address, and nearly all are slow and unsystematic in their correspondence. . . . Shipping arrangements to Siam are also defective, as much as four or five months sometimes elapsing between shipments from New York (whence we get most of our goods) and arrival in Bangkok.

In consequence, we often prefer to order dearer or inferior articles from Europe, to avoid delay and uncertainty.

The packing of the goods, I am pleased to report, has been materially improved during the last year. While one lot has come in a most unfortunate condition, yet the importers, on the whole, report satisfaction in this line now. It is to be hoped that the improved condition of shipping with all the Far East that will come with our more direct communication with the Philippines will remedy some of these difficulties; and this, together with attention on the part of our manufacturers to those points to which reference has already been made in this article, will put America in possession of her share of this trade in Siam.

I call attention to the following extract from an interesting letter from Vice-Consul-General L. E. Bennett, which was published recently. Since Mr. Bennett wrote, I learn that the contracts are being made in this city and not in Copenhagen.

With reference to present work in Siam, I beg to state the following:

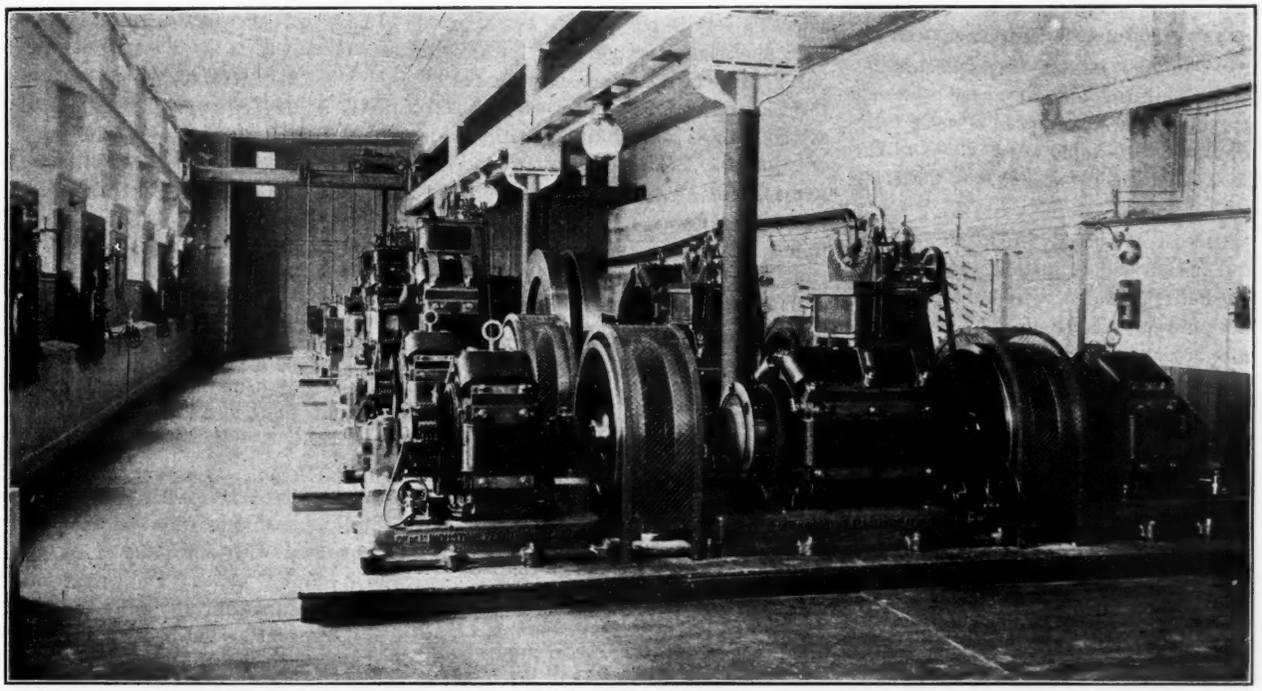


FIG. 3.—MOTOR GENERATORS IN RECEIVING STATION OF THE RENTERIA POWER TRANSMISSION LINE.

Tramways—Mr. A. Westenholz has just secured a new concession to make about five miles of new electric street railway line in the city of Bangkok, and has effected the consolidation of the present existing street railway line, about six miles in length and operated by electricity, with the electric light company, so that the present central lighting plant and the existing electric street railway line and the new proposed line of about four miles will all be operated as the Siam Electricity Company, Limited. Their capital will be about $500,000, gold.

The electric power will be supplied by the lighting company, which will now run day and night, and some additional machinery will be required by the company for operating the new lines; also rails, ties, fastenings, insulators and copper conductors.

The existing line of about six miles in length will require, at the same time, to be relaid with new rails, as the present rails are about worn out.

The work will probably be started at once.

The leading importers of electrical supplies in this city are the Siam Electricity Company, Limited, the Siam American Trading Company, and the Bangkok Dock Company.

Export Notes

On her last sailing for Genoa from New York city the steamer Aller had aboard $30,000 worth of electrical machinery, and heavy consignments of general electrical apparatus for Milan.

Manchester, England, was the port of destination for $25,000 worth of trolley poles, $38,000 worth of electrical material and $53,600 worth of finished steel, shipped by recent steamer.

A Glasgow, Scotland, engineering firm has chartered a vessel of some 4,000 tons burden for a series of eight voyages from this country to Welsh ports. The vessel will carry nothing but Carnegie steel.

One of the largest consignments of electric railroad material ever sent to Rangoon, India, was shipped recently from New York. Its value was $120,000. On the same steamer was $38,000 worth of steel.

The cost of the Mysore, India, power plant, which will be installed at the Cauvery Falls, is stated, will be $1,250,000. The contract was secured by American manufacturers against universal competition.

Belleville, Ont., is to be lighted by Dean, Shipley & Company, of New York, for a long period. This firm has secured the electric light and street railway franchises for that city and will issue $450,000 in bonds.

A shipment of general electrical material, which was made during the first week in December to London, was valued at $35,000. It is stated that this shipment was for home consumption and not for reexportation.

An expenditure of $8,000 for telegraph and telephone supplies has been authorized without the formalities of bids by the Director General of Posts and Telegraphs at Madrid, Spain. The purchases will be made early in January.

The Japanese Imperial Navy, which has of late years been adopting more and more American electrical apparatus, has recently sent a representative to this country with full power to place heavy orders for structural material for the Arsenal at Kuri, which will have a very complete equipment both in its steam and electrical departments.

Card catalogues recently got out by American export houses and sent to Consul General Holloway, in St. Petersburg, Russia, have amply proven their utility as Colonel Holloway had inquiries from over a dozen persons in that city within 24 hours after the matter appeared in the local newspapers. One Moscow merchant submitted a list of 12 classes of exporters whose addresses he desired.

The Spanish Government has recently published a report showing the extent to which European countries are interested in the electrical arts in Spain. At present Madrid has 12 power stations. In the entire kingdom there are 443. Two of the former supply power for street railways, nine for lighting, and the twelfth plant, now in process of construction and which will be the largest of all, is to supply power for both purposes.

Pensacola, Fla., has never been considered a very important city as compared with the larger seaports of the North, but a glance at its gross export figures for the last week of November will probably astonish those unacquainted with southern industry. The exports in question were valued at $539,571, and were distributed as follows: Liverpool, $260,106; Genoa, $119,897; Venice, $84,348; Glasgow, $29,202; Rotterdam, $21,374; Sunderland, $46,925; Buenos Ayres, $7,709.

In Spain several large enterprises are reported, the most important being one which is projected by Señor Enrique Aresti y Torres, of Bilbao, which is intended to utilize the River Nalon in Asturias. Another similar scheme to use the river Ebro is being promoted by Señor Romero, of the same city. A large number of other new electrical enterprises have recently been started, the capital for many of them coming from Cuba and Puerto Rico. Engineers and contractors who desire to obtain further particulars may address the United States Consul in Bilbao, but if they desire to send catalogues, price-lists or correspondence to the parties interested all such matter should be in the Spanish language.

Dr. H. Igarashi, director of the Imperial telephone service in Tokyo and Yokohama, Japan, is in the United States looking up new telephone devices and is said to have been considerably impressed with the fact that more than 7,000 telephones are in operation in the city of Minneapolis, Minn., while in Tokyo, his native city, whose population is one million and a half, there are only 7,000 instruments. The Imperial Government has, however, orders for 10,000 more and will secure the latest and most modern equipment for this rapidly increasing service. Dr. Igarashi further stated that the Bell system is at present used and owned by the government. Very little underground work is seen, the wires being strung overhead and the construction used is very similar to that employed in the United States. No nickel-in-the-slot or measured service instruments are used in Japan since the rates charged are very low—equal to about $30 a year in American money.

There seems to be a good opportunity for American coal producers to secure at least part of the contracts for the Chemin de Fer de l'Etat (French State Railway) for 40 to 50,000 tons of coal, the conditions being as follows: 1. The coal is to be delivered at La Rochelle, probably in the basin known as La Pallice, in the company's cars. 2. The price per ton must include cost, transportation and duty. The duty is 1.20f per metric ton. 3. Payment is made within 15 days after delivery. 4. The prices paid by the government for their last purchases were about as follows: Fine coal (menu), containing a large percentage of dust, 27.50f per ton; coal with a fair percentage of lumps (25 to 30 per cent), 32.80f per ton. The prices referred to are to be "franco," that is, the seller to pay the duty, the coal being delivered on cars alongside ship. Heretofore the railway has been accustomed to pay a premium for better fuel than the contract called for and to diminish the price of coal proven inferior than demanded in the tenders. The road is stated to burn 220,000 tons annually.

A newspaper report states that the Philippine Company, which has been incorporated with a capital of $1,000,000, will bid for railway and street railroad franchises covering 300 miles on the island of Luzon, after the passage by Congress of the Spooner bill which provides for the Philippines. The counsel for the company, Mr. William H. Stayton, said in a recent interview that an electric railway 300 miles long will be laid, providing the franchises are granted, from Dagupan through Manila to the southern end of the island. Electricity will be used as it is less expensive than steam power. In both Manila and Dagupan street railway franchises will be bid for as both of those cities are populous and need street cars. Mr. Stayton is said to have further stated that he expected the overhead trolley railway from Dagupan to the southern end of the island to rapidly develop that part of the country, and though there is a railroad from Manila to Dagupan now it is only an inland road, while the Philippine Company's plan is to make the road extend to the coast. The company's electrical engineer, A. N. Wheatley, of Chicago, is said to have sailed a few days ago from San Francisco for Manila in order to be there in time to bid for the franchises.

Wall Street and the Electrical Stock Market.

On the New York Stock Exchange, General Electric closed the week at 191 bid and 193 asked, showing a loss of 4 points. Metropolitan Street Railway, of New York, closed at 170⅞ bid and 171 asked, indicating a loss of 3⅛ points for the week. Brooklyn Rapid Transit closed at 85⅞ bid and 86 asked, showing a gain of 2⅜ points. Third Avenue Railroad closed at 118 bid and 120 asked, showing a gain of 1 point for the week. Manhattan Railway, of New York, closed at 114⅞ bid and 115 asked, indicating a gain of 1⅝ points for the week.

On the Boston exchange, American Telephone and Telegraph closed at 154½ bid and 155½ asked, showing a loss of ½ point. Erie Telephone closed at 99 bid and 100 asked, indicating a loss of 1 point.

On the Philadelphia exchange, Electric Storage Battery was not quoted. Electric Company of America closed the week at 9¾ bid and 9⅞ asked, showing a gain of ¾ point. Union Traction closed the week at 36⅜ bid and 36½ asked, indicating a gain of ¼ point.

On the curb, or outside market, in New York, Electric Vehicle closed the week at 20 bid and 21 asked, indicating a gain of 2¾ points. Electric Boat closed at 28½ bid and 29½ asked, indicating a loss of 1½ points for the week. Consolidated Equipment closed the week at 13½ bid and 13⅝ asked, showing a gain of ⅛ point.

Wall street, December 29, 1900.

PERSONAL.

Mr. W. R. Mason, who has recently been the St. Louis manager for the Siemens & Halske Electric Company of America, will hereafter act as district manager for the Northern Electric Manufacturing Company, of Madison, Wis., and the Stanley Electric Manufacturing Company, of Pittsfield, Mass. Mr. Mason has taken offices at 110 Laclede Building, St. Louis.

Mr. Chas. H. Schum, who has been with Messrs. F. A. La Roche & Company, of New York city, for the past four years, has resigned his position as electrical engineer to accept a position with the Bergmann Electromotoren und Dynamo Fabrik, of Berlin, Germany. Mr. Schum is a graduate of Sibley College, Cornell University, Class of 1895, and has had an extensive experience in switchboard and dynamo practice. He is also an associate member of the American Institute of Electrical Engineers. Mr. Schum left New York for Germany on the Kaiser Wilhelm der Grosse, which sailed on January 3.

LATE NEWS.

An underground conduit is being installed by the Fergus Falls, Minn., local telephone company. The conduit is a 12-duct tube and will contain two cables of 100 and 200 wires each.

A newspaper despatch from Washington, D. C., says that Nikola Tesla has been asked by Rear Admiral Royal B. Bradford, U. S. N., chief of the Bureau of Equipment, to submit to the Navy Department a trial wireless telegraphy system perfected by him.

The Riker Motor Vehicle Works, at Elizabethport, N. J., were partly destroyed by fire on the night of December 29. Several unfinished electromobiles were burned as well as a considerable quantity of raw material. The loss is estimated at from $40,000 to $60,000. The plant is valued at $500,000 and about 300 men are employed.

The annual report of the Texas Railroad Commission, which has just been filed with Governor Sayers, contains a number of legislative recommendations, the most important of which is that a law be passed giving the Railroad Commission the power to regulate the rates and charges of all telegraph and telephone companies doing business in Texas, and compelling all such companies to maintain general offices in that state.

Meetings of the stockholders of the Edison Electric Illuminating Company of Boston and the Boston Electric Light Company will be held within two weeks to consider a proposition to combine the two companies. Each company now pays eight per cent dividends and is said to earn a great deal more. The new plan is to eliminate competition and to enable the stockholders to receive large surplus earnings. Mr. J. Pierpont Morgan is the largest stockholder in the Edison company and rumor credits him with arranging the details of the proposed consolidation.

Recent press despatches from Chicago announced that a system of duplex telephony had been adopted by the Chicago Telephone Company, by which two conversations could be held simultaneously. The ELECTRICAL REVIEW is informed that this statement is an error, which arose from the fact that the Chicago Telephone Company had announced a lower rental which involved the use of a second telephone line and a second telephone at $75 a year. This is a lower price than the company has had heretofore and to a great many subscribers who have an overloaded wire, having but one line and one telephone, the auxiliary instrument will act as a relief to their traffic.

Gas Thermometers.

The use of gas thermometers at high temperatures is the subject of an interesting paper by Messrs. Holborn and Day, in *Wiedemann's Annalen*. Experiments with porcelain vessels, glazed and unglazed, have shown that this material is unsuitable for the construction of the containing vessel, especially when the gas used is hydrogen. Platinum iridium vessels (10 or 20 per cent iridium) containing nitrogen appear to be very trustworthy; after the thermometer has been heated to 1,100 degrees centigrade for a considerable time, the indications of the instrument at low temperatures remain unaltered. The thermo-elements usually employed for the measurement of high temperatures have been carefully compared with this gas thermometer and the electro-motive force represented as a quadratic function of the temperature. With these thermo-elements the melting-points of a series of metals have been determined, so that the calibration and control of other elements is made independent of the standard nitrogen thermometer. The authors claim that the error in the determination of high temperatures (up to 1,150 degrees centigrade) does not exceed one degree centigrade. The influence of air on the melting-points of copper and silver is interesting, as is evident from the following numbers: Copper (pure), 1,084.1 degrees centigrade, (in air) 1,064.9 degrees centigrade; silver (pure), 961.5 degrees centigrade, (in air) 955 degrees centigrade.

OBITUARY.

William H. Moore, aged 46 years, died at his home in Plainfield, N. J., on December 26, of typhoid fever. Mr. Moore had served two terms in the Plainfield common council, and at one time was associated with Mr. Thomas A. Edison. He made several trips abroad for Mr. Edison, one of them being to Japan to secure samples of bamboo to be used as filaments in incandescent lamps. Mr. Moore's travels resulted in his being successful in finding the special type of bamboo which was used in the filament of the early Edison lamps.

It is stated that the Iowa Telephone Company is soon to be absorbed by the Central Union Company and the Iowa stockholders have agreed to exchange all their holdings for Central Union stock, as most of the $769,900 stock and of the $200,000 in bonds of the Iowa company are owned by two other Bell concerns—the Central Union and the American Telephone and Telegraph companies. There was no protest among the Iowa's stockholders.

Automobiles

Connecticut has a regularly incorporated automobile club which has been recently chartered for $5,000 and will have its headquarters at Bridgeport.

The Shah of Persia is reported to have recently traveled from the border to Teheran, the capital, in an automobile manufactured by a French firm.

A rather curious incident occurred recently in Boston when a horse was pulled by an automobile out of a hole into which he had fallen and where he was stalled.

Another automobile club has been formed in Boston and will have its clubhouse in Brookline. The new organization will be incorporated under the name of the Automobile Club of New England.

The city of Pittsburgh, Pa., has a motor fire engine and hose carriage in its fire department. The motive power of the engine will of course be steam while that of the hose cart is electricity.

Recent incorporations in automobile circles include that of the Michigan Automobile Company, of Grand Rapids, Mich., chartered for $50,000 by W. S. Daniels, of that city, and B. J. Carter, of Jackson.

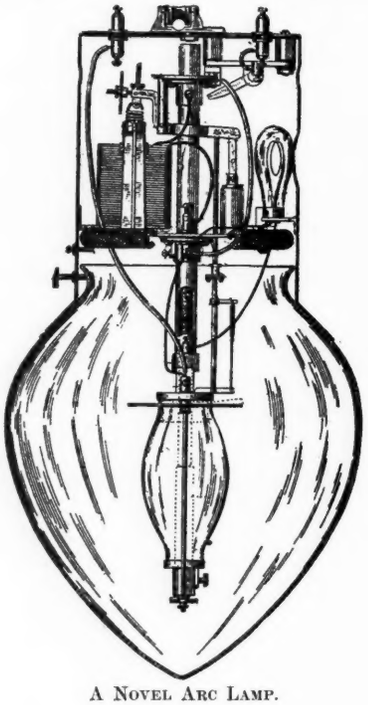
A Chicago evangelist is reported to have asked for contributions looking toward the establishment of gospel automobiles. "If you can not give $1,000, give $500," he is reported to have said. As an inducement he offers to name an automobile after any one who sends him a complete outfit.

An automobile club has been formed in Mt. Vernon, N. Y., by a number of well-known New Yorkers, many of whom own country seats on the northern shore of Long Island Sound and throughout Westchester County. The new organization will be known as the Westchester Automobile Club.

The contractor who holds the contract for carrying Boston's mail is said by local papers to be interested in motor vehicles, and though it can not be stated with absolute certainty that automobiles will be used for delivery there seems now every probability that such will be the case. The contractor refuses to either deny or confirm the report.

New Haven's (Ct.) police department is said to be drafting a bill which will be presented to the Connecticut Legislature in January, regarding the speed of automobiles. Complaints have been received from all over the state regarding the high speeds indulged in and the police department will endeavor to regulate the matter and fix a maximum rate for all vehicles.

Tours in automobiles seem to be quite *au fait*. Twice within four years an Indiana newspaper has sent a representative on a bicycle throughout the state to obtain authentic information about the roads and get other information which would be of assistance to wheelmen, and recently instead of sending its bicycle man the enterprising paper despatched an automobile on the same service to show the advantages and disadvantages of touring in such machines.



A Novel Arc Lamp.

An interesting race occurred in New York recently when the automobile ambulances of the Presbyterian and Roosevelt hospitals chanced to meet on Fifth avenue in the evening. Both machines had left their patients at the hospitals and were returning to the stables and chanced to meet at Twenty-sixth street; from there to Fifty-ninth street it was nip and tuck, but at length the Presbyterian ambulance forged ahead and was half a block ahead at the finish.

Motor vehicle manufacturers have become organized and at a recent meeting in New York they decided to form an organization known as the National Association of Automobile Manufacturers. The following officers were elected:

S. T. Davis, Jr., president; John H. Flagler, first vice-president; J. Wesley Allison, second vice-president; D. S. Walker, treasurer; E. P. Wells, secretary; board of directors, comprising 15 members, to serve for one, two and three years, respectively: Three years—John Brisben Walker, C. J. Field, E. P. Wells and Alexander Winton; two years—J. M. Hill, A. L. Riker, W. C. Baker, R. A. Ballantine and John H. Flagler; one year—S. T. Davis, Jr., F. T. Bradbury, W. T. Duryea and a representative of the Daimler Manufacturing Company.

Under the caption of "Runaway Automobiles" the *Horseless Age* recounts an incident which occurred recently in Indianapolis. A curious boy climbed into a vacant automobile standing by the curb, turned on the power and jumped out. The machine having a clear field got up considerable speed and was doing nicely until it attempted to knock down a trolley pole. Both were wrecked. In the same city a few weeks before that a horse, who was stated to be of an inquiring turn of mind, was left standing facing an automobile whose owner had left it for a few moments. Moving up to the machine the horse mischievously pushed the bar with his nose, whereupon the automobile ungallantly pushed horse and carriage on to the sidewalk. The animal put up a determined fight for his rights, but was driven back inch by inch, and when the combatants were separated the automobile had decidedly the best of it.

A Novel Arc Lamp.

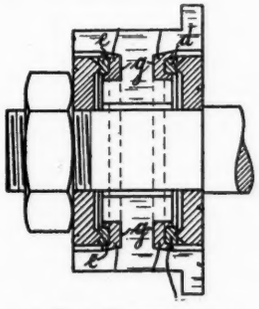
In the accompanying illustration is presented an arc lamp which is the invention of Mr. J. H. Hallberg, of Peabody, Mass., and assigned by him to the Helios-Upton Company. At the top of the lamp is a double-throw switch and a bare wire resistance coil with means for adjustable connection thereto, to adapt the lamp for either direct or alternating-current circuits. The lamp-shell, or casing, has an aperture in its side large enough to afford a view of an incandescent lamp inside, which, by means of an adjustable contact, receives the current when the upper carbon is nearly consumed. By means of this incandescent light ample notice is given that the arc lamp needs trimming, thus obviating the removal of outer and inner globes to ascertain how much there is left of the carbons.

Reports have lately been increasing regarding the electrolysis scare felt by the water companies in various cities throughout the country, and now a despatch from Albany, N. Y., states that one of the telephone mains in that city has been recently severely damaged by the electric current, though no trouble has been so far experienced by the water department. The electric company is said to have settled the affair amicably and so arranged that it can not occur again.

Recent Electrical Patents

Mr. Frank A. Marrick, a resident of Johnstown, Pa., has been granted a patent on a simple little device to be applied to a trolley head, and which is designed to prevent arcing and sparking due to momentary separation of the bearing surfaces of the wheel and spindle by reason of the vibrations or play of the wheel. The invention consists of a pin slidably mounted in an opening in the bearing of the head. This pin is arranged to bear upon the axle, and in order to hold it in this position a spring is secured to the journal bearing and rests upon the projecting end of the pin to hold it down. The invention has been assigned to the Lorain Steel Company, of Pennsylvania.

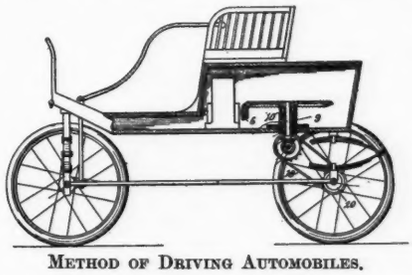
A new commutator that embodies several important points has recently been patented in the United States by a German whose name is Fritz Kaeferle, and whose residence is Hanover, Germany. An axle is provided on which a pair of disks are mounted, one being rigidly fixed to the axle, the other fitting snugly thereon, but movable backward and forward. The body of the commutator is formed of a plurality of lamellæ separated by any suitable intervening insulating material, the whole being provided on each side with annular ribs or grooves, in which rings consisting of some good insulating material snugly fit. This body portion sur-



A New Commutator.

rounds the axle but does not rest upon it, an annular chamber being thus formed which allows for the contraction and expansion of the body under influence of changing temperatures without disturbing its form. Another pair of rings is placed upon the first-mentioned rings, and the disks are provided with V-shaped annular ribs which bear against these last-mentioned rings. The end of the shaft is screw threaded, and a nut operated thereon is arranged to force the movable disk towards the stationary one, and thus clamp the body tightly between the two. By this means a very simple device is formed, in which there is little liability of the elements becoming separated, and yet, should it become desirable to change the body, the lamellæ may be readily removed and replaced.

Another patent has been issued on a decidedly novel manner of driving motor vehicles. In this case the motor is mounted within the body, and preferably directly beneath the seat, where it is completely



Method of Driving Automobiles.

enclosed, and thus protected from all dirt and dust. The motor shaft carries a small bevel pinion which meshes with a large gear wheel, secured to the upper end of a vertical shaft that passes down through to the under side of the vehicle body. A transversely arranged horizontal shaft is supported by suitable brackets directly beneath the body and is provided intermediate its ends with a bevel-gear wheel, that meshes with a similar wheel upon the lower end of the vertical shaft. Both ends of the transverse shaft have sprocket wheels and similar sprocket wheels are secured to the rear wheels of the carriage or vehicle. These respective sprocket wheels are connected by suitable sprocket chains. As it is necessary in machines of this kind to provide a small rapidly running motor, this simple mechanism provides gears which greatly reduce the speed with a consequent increase of power. Furthermore, the entire mechanism is out of the way, and, as ball-bearings are used, friction is reduced to a minimum. The invention is the idea of Mr. Bernard Berendsen, a resident of Milwaukee, Wis.

COPPER EXPORTS.

Exports of copper, ending with October 30, are given by the United States Treasury Department in the following table. The comparison between the figures for the different years is interesting:

Ingots, bars, etc., lbs.:	1900.	1899.	1898.
To United Kingdom..	56,186,403	38,621,239	68,530,104
To France.....	59,434,048	44,239,845	41,906,190
To Germany.....	60,957,802	39,828,447	36,174,108
To other Europe.....	121,985,019	64,572,634	88,267,914
To B. N. America.....	1,298,467	849,445	1,264,817
To Mexico	292,176	249,273	237,742
To other countries....	6,826	27,450	171,749
Total....	300,160,741	188,388,333	236,552,624
Copper matte tons:			
To United Kingdom..	4,402	463	4,350
To Germany.....	300	.....	2
To Mexico.....	3,242	2,169	3,026
To other countries....	73	.....	.....
Total.....	8,017	2,632	7,378
Total value.....	$50,204,676	$31,539,113	$27,636,060

Telephone and Telegraph

An independent telephone exchange will soon be installed in Lafarge, Wis.

Telephone lines are being strung between Crookston, N. D., Beltrami, Gary and Fertile.

J. W. Edwards, of Phoenix, Ariz., has recently purchased the city telephone exchange of Aledo, Ill.

Certificates have been filed in Ottumwa, Iowa, by the Ohio Telephone Company for an increase of its capital stock from $40,000 to $75,000.

A franchise has been granted by Grand Rapids, Mich., to the Citizens' Telephone Company, which will build and maintain a telephone exchange in that city.

Two telephone lines will be constructed in the near future in Quincy, Ill., one connecting that city with Ambrose, in Hancock County, and the other with Clayton.

Negotiations between the Southern Bell Company and the local company of West Point, Ga., have resulted in plans which will assure that city of first-class telephone service.

The Kinloch Telephone Company has been granted a franchise in Edwardsville, Ill., to erect poles and string its wires along the streets of that city and also to make connections with cities and towns in the vicinity.

A franchise has been granted to the Fayette Telephone Company, of Lexington, Ky., to build and maintain an exchange in that city to connect with surrounding towns.

A permit has been granted by the officials of Toronto, Canada, to the Bell Telephone Company for the erection of a two-story brick office, which will be erected at a cost of $2,000.

Brown County, Ind., which at the present time possesses neither railway nor telegraph facilities, is soon to have a telephone system. Franchises are said to have been asked for and the promoters of the plant confidently expect to receive them.

Telephone extension in Utah has reached north from Salt Lake City toward Samaria and that settlement is now in communication with Ogden and the lines will soon reach Mallad. Southward the extension reaches Mt. Pleasant. Seventy-four new telephones were installed in Salt Lake City during October.

Electric Lighting

Brazil, Ind., has recently contracted for a $19,000 electric plant.

A new dynamo of 2,000 lights capacity has been recently installed in Rensselaer, Ind.

Cuba, Ill., has a $10,000 electric light plant in which the current was turned on during the past week.

The city fathers of Creston, Iowa, are figuring with a Des Moines contractor for an electric and gas lighting plant.

The Lebanon, Ore., Electric Light and Water Company will soon install a new electric light system in that city to replace the present incandescent service.

A ten years' contract has been granted by the city council of Portsmouth, N. H., to the Portsmouth Electric Light and Power Company, for lighting the streets of that city.

A press despatch from Martinsburg, W. Va., states that the erection of a municipal electric light plant in Hagerstown, Md., has resulted in decreased charges for lighting houses in that city.

A report from Pennsylvania states that the Harrison Light and Power Company and the township committee of that village have agreed to continue the present system of lighting in Mullica Hill.

Plans have been drawn for the construction of a $30,000 power-house in Kenosha, Wis., for the Kenosha Electric and Gas Company, and work on the new building will be started as soon as possible.

The cost of installing the electric lighting plant in Ilion, N. Y., is stated to be $30,088.60. Two circuits will be run, street and commercial, and the proceeds from the latter it is believed will prove a paying investment.

Current was turned on in the plant of the Shamokin, Pa., Light, Heat and Power Company, on December 15. The plant measures 100 by 200 feet, and was erected at a cost of $175,000, the building alone costing $30,000.

Ravenswood, W. Va., has determined, if possible, to own its own electric lighting plant and the proposition of issuing $8,000 in bonds for that purpose will be discussed by vote at the municipal election on the first Thursday in January.

A report from Pittsfield, Mass., states that Miles Dunham is endeavoring to purchase an electric light plant for the illumination of that city. Local parties are also interested and are giving the promoter all the encouragement possible.

A company in La Salle, Ill., has for some time past been agitating a franchise for electric lighting, and at a recent meeting of the special fire and light committee the matter was taken up for consideration, but no definite conclusion was reached.

Citizens of College Hill, near Beaver Falls, Pa., recently voted for the issuance of $12,000 in bonds to erect an electric light plant. The matter was considered to be unanimously popular, as out of 91 votes only three were cast against the plant.

Two new arc lighting machines costing $2,000 were recently installed in Merrill, Wis., by the Merrill Railway and Lighting Company. When this service is supplemented with the new machines it is stated that no city in Wisconsin will be better lighted.

Bryn Mawr University, in Pennsylvania, has asked the city authorities for $100,000 for a heating and lighting plant. Such a plant connected with the institution would greatly increase the efficiency of its curriculum and facilitate higher education in the electrical arts for women.

A company has recently been incorporated in Guthrie, O. T., to furnish electric power for light and heating plants in Chickasaw. The capital stock of the new company is $250,000 and the incorporators are A. B. Campbell, of Minco, I. T.; H. B. Johnson, of Chickasaw, and E. E. Blake, of El Reno.

A corporation to be known as the Empire City Gas and Electric Company was incorporated on December 13 in Trenton, N. J., with a capital stock of $500,000, to supply heat, light and power. Its incorporators are G. W. Lynch, Martin Caflesch and John T. Underhill, all of Jersey City.

The Monongahela Electric Light and Power Company, of Pennsylvania, has denied the report that its plans for a big electric light plant at Rankin had fallen through and recently stated that the Homestead plant will be torn down and that borough will in future be lighted by power supplied from Rankin.

Papers have been filed with the city officials of Alton, Ill., showing the transfer of the rights and franchises of the Alton Electric and Service Company to the Alton Railway, Gas and Electric Company. President Vreeman and J. H. Blessing, for the new company, are reported to have sold to the old company all their interests and machinery. No price was stated.

Minneapolis, Minn., is to have cheaper electricity, as the General Electric Company, of Minneapolis, has announced a new method of computing charges for current, which is practically one-third lower than formerly to persons who use their lights more than one hour per day. The company's policy is believed to be in the line of reducing rates as fast as the patronage increases, so as to give the greatest benefits to those who use its current.

Fire entirely destroyed the plant of the Citizens' Light and Power Company, Rochester, N. Y., between one and six o'clock on the afternoon of November 25. The total loss is estimated at $160,000, which is partially covered by insurance. It is said that friction was probably the cause of the fire, there being a short circuit. The dynamo man lost control of his two water-wheels, one of the rope drives jumped a pulley, and the resulting friction caused sparks which ignited the oil-soaked floor. No one is held responsible for the fire, as it appeared unavoidable.

Mr. J. D. Houseman, manager of the St. Louis, St. Charles & Western Railway Company, is reported to be negotiating for a franchise to lay conduits along the various roads in St. Louis County, Mo., for electric light and power. As a result of Mr. Houseman's notification to the County Court that body postponed for another week the granting of a franchise to the Arial Electric and Manufacturing Company, which has had a petition pending in court for the last month, the object being to see whether Mr. Houseman or the first petitioner would make the better proposition.

The Pueblo, Colo., Traction and Electric Company went out of existence on December 7, having been absorbed by the Pueblo Traction and Lighting Company, whose incorporation articles were filed with the Secretary of State and show a capitalization of $1,500,000 stock. It is stated that the reason for the absorption of the old company and the incorporation of the new is the desire of the directors to increase their bond issue to a figure commensurate with the improvements they wish to make, the capitalization of the old company being but $500,000 and the bond issue run out. Some time previous to this step the old company realized that the improvements which had been made in the city would necessitate their extending their own facilities and action was accordingly taken.

A British View.

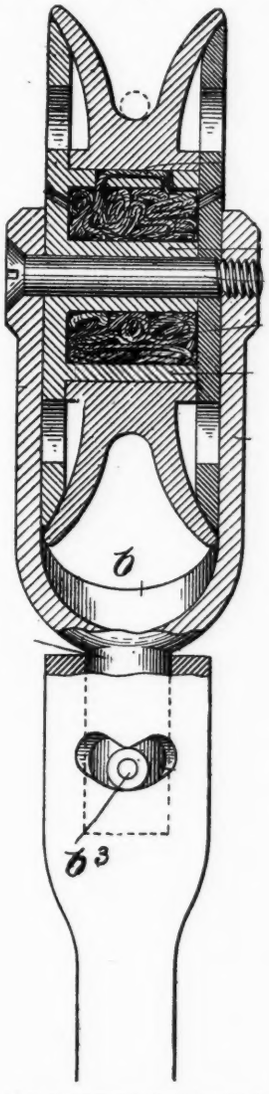
It is satisfactory to know that British engineers and manufacturers are seriously examining the causes which have enabled German and American works to successfully compete with their productions. Sir Lowthian Bell dealt with the subject in his address to the Institution of Junior Engineers on November 30. In the course of his remarks he said: "Some correspondents of our newspapers attributed our loss of ground in the race to ignorance of the scientific truths on which success was dependent; but they could not be aware that at Newcastle, Leeds, Nottingham, Sheffield, Edinburgh and Glasgow there were large and well-appointed colleges for teaching the sciences which for the last 25 years had been deemed indispensable in Great Britain for a successful career in metallurgy. Moreover, every iron works of any importance possessed a suitable laboratory as a guide in its daily operations as well as for original research. Comparison between the United States and England involved two conditions—that imposed by nature, and that resulting from ignorance and consequent want of skill; the former was unavoidable, the other susceptible of remedy. Now, taking the Middlesborough district in this country and Pittsburgh and its vicinity in America, it appeared that the final cost of the minerals, mining and carriage included, consumed for each ton of pig iron at Pittsburgh and Middlesborough was almost identical." Though Sir Lowthian Bell's estimate of the alleged advantages of the Pittsburgh works may do something to reassure British manufacturers, his remarks as to educational facilities and industrial research are not so convincing. True, we have our university colleges and technical schools, but in how many districts are they considered by the manufacturers to have any real connection with industrial progress? When the business man really believes in such institutions, he does not regard them merely as places where a smattering of useful knowledge can be obtained, but as laboratories where adequate provision has to be made for scientific research. As for the laboratories provided for investigation in iron works and other manufactories, they are as nothing in comparison with what they ought to be. When they do exist, they are often regarded as failures unless every year the cost of their upkeep is less than the saving they effect. What British manufacturers mostly lack is belief in scientific results and sympathy with the scientific spirit. So long as they are deficient in these qualities, they will be unable to derive the fullest advantage from scientific progress.—*Nature.*

Convention of the Northwestern Electrical Association at Milwaukee.

The convention of the Northwestern Electrical Association will be held at Milwaukee, Wis., on January 16, 17 and 18 next, when the following papers will be presented: "The Rate Question," by Henry L. Doherty, New York; "Synchronous Converters," by Professor W. E. Goldsborough, Purdue University; "The Series Incandescent Lighting System of the Future," by P. D. Waggoner, Schenectady, N. Y.; "Practical Line Construction," by Loren W. Burch, Madison, Wis.; "Education of Central Station Employees," by Professor D. C. Jackson, Wisconsin University.

Other papers not ready for announcement will be read, and the session promises to be one of great interest.

Finished iron has recently been shipped to Mexico in heavy consignments, one which was made a few days ago being valued at $25,000.



A Self-Lubricating Trolley.

A Self-Lubricating Trolley.

Among the most interesting of recent inventions which have been designed and patented for street railway purposes is the trolley harp and wheel invented by Francis A. Le Court, of Rockport, Mass., which is a device whose principal value is said to be not so much in the bracket and socket of the harp as in the wheel itself, which will fit any bracket now in use on trolley cars.

Roughly stated, the apparatus consists in novel features of construction and arrangement, for which the claims are as follows: The bracket supporting the wheel is provided with a spindle at its lower end, journaled in a socket in the pole and provided with a roller stud occupying a slot in the end of the pole next the bracket. The spindle of the bracket is adapted to rotate freely in its socket within the limits of its slot-and-stud connection with the trolley pole, the formation of the slot being such that the stud seeks the lowest point of it by reason of the weight of the bracket and its attachments, or on account of the pressure of the trolley against the wire. Thus the bracket is normally held in a central position, but is so arranged that it turns upon the pole when torsional force is applied, as when running curves, thus maintaining the trolley wheel parallel to the wire and reducing its liability to jump off. The wheel itself consists of three portions, both of which embody radial flanges at their outermost ends, facing inward, and one has a core in its centre which engages with the central portion, which is formed as the pulley or rolling part of the device for direct contact with the wire, the three being fastened together with a long screw-bolt through the centre as will be seen in the accompanying illustration. The central portion of the wheel contains two cavities in which wicking, cotton waste or other absorbent material is placed and saturated with some heavy lubricant, the ends of the absorbent being placed in an orifice through the side of the chamber which allows the lubricator to escape into that orifice and thus thoroughly grease the bearings of the wheel. As will be seen in the illustration the large centre aperture of the trolley wheel and the long hub formed therefrom give an unusually large bearing, which causes a reduction of wear in the operation of the trolley, this having been ascertained by experiments to be the life of an apparatus of this description. One of these wheels was used on a road in Rockport, Mass., in constant local service and covered 8,000 miles before wearing out.

Electric Tramways in Barcelona, Spain, and Vicinity.

Referring to my former report on electrical tramways in Barcelona, writes Consul General J. G. Lay, from Barcelona, I beg to transmit the following particulars regarding the progress made toward completing roads already in course of construction, and what has been accomplished in organizing companies and obtaining concessions and franchises for projected roads, as well as those to be changed from horse and steam to electric traction. In as many cases as I have been able to obtain them, the names of the chief contractors or persons who are likely to have charge of the purchase of construction material and equipment are given.

1. Compañia Anonima; owned entirely in England; completed and running through the principal streets of Barcelona with a double track of about 25 miles. The chief contractors were Messrs. Dick, Kerr & Company, of England. The trolley wire, trucks, electrical machinery, engines, and motors all came from the United States.

2. Ensanche line (not named). This line now runs horse cars, and is owned by another English company, although the directors are those of the Compañia Anonima, in conjunction with which it will be operated and connected. The plans and specifications are now being prepared to change the present system of horse traction to electric, and probably the same firm—Dick, Kerr & Company—will be its chief contractors. This road will be about four miles in length, and, although single track, the wirework necessary will be as much as if for a double track.

3. Barcelona-Horta Extensiones; will run from outskirts of Barcelona to town of Horta, eight miles distant, with a single line. This road I have already reported on, and is about half completed. The contracts are all let.

4. Barcelona and San Andres. This line, at present steam, is to be changed to electric very soon, as permission for the change has been granted by the Spanish authorities. The same company as the Barcelona-Horta line owns this one, with five and one-half miles of double track. No contracts for building this line have yet been let, but information regarding them may be obtained from the Société Anonyme d'Enterprise de Trauvaux, Liege, Belgium. This company will also build an electric tramway from San Andres to Horta, a distance of two and one-half miles.

5. Barcelona to Badalona *via* St. Martin; now steam; 10 miles; G. H. Gillis, manager. Nothing has been done towards any change, but the power-house now under construction for the Barcelona-Horta Extensiones is being built to furnish power to the three last-named lines.

6. Compañia General de Tranvias. The present German company has purchased franchises and concessions of the former owners, and the change from steam to electricity should soon be made, as the permanent way has been relaid for five and one-half miles. Contracts for cars and equipment have not as yet been let. Details of same may be obtained from Mr. Fengercroff, representing the technical interests of the German stockholders here.

7. Barcelona to Sans; a mule line of eight miles, running from the centre of the city. This line has lately been purchased by German capitalists, intending to introduce electric traction, but they are having some difficulty in obtaining a franchise, owing to the narrowness of streets through which they wish to run, and the objection of property holders to span wires and of the authorities to the poles. The company will probably be compelled to put down underground conduits in the city and trolley in the suburbs. No contracts have been let for this line nor has the chief engineer been appointed.

The only hindrances to the sale of American electrical goods in Spain, when the prices are the same as those of similar articles from other countries, are the higher duties levied on American imports than on those from nations under the "favored-nation clause," and, of course, there is a prejudice in favor of obtaining machinery and equipment, every thing else being equal, from the country of the principal shareholders. A direct line of steamers is now running monthly between New York and Barcelona.

A refuse destructor and electrical generating works are to be constructed in London, England, by the vestry of Hackney, one of the northeastern suburbs of that city. Machinery will be installed which will have an initial energy of 3,000 horsepower, which will be sufficient, with accumulators, to provide a current for 50,000 eight-candle-power lamps, the engines driving the dynamos being of the triple-expansion type working at 175 pounds per square inch. Two dynamos will be driven direct by each engine and a common condenser and cooling apparatus connected therewith. The refuse destructor will consist of 12 furnaces with a daily burning capacity of 150 tons, the total cost of the plant amounting to about $1,250,000, but the vestry authorities anticipate an economy of $20,000 a year. Charges will be made for electric lighting to both private and public consumers at higher rates than for the supply of power.

Large Engines for the Kings County Electric Light and Power Company, Brooklyn, N. Y.

Among the large new engines recently built at the Westinghouse Machine Company's shops, the most conspicuous are two huge compound Westinghouse-Corliss engines of 5,000 horse-power each, built for the Kings County Electric Light and Power Company, of Brooklyn, N. Y.

These twin engines, which have been erected temporarily on the floor of the new shop, are of the vertical type. They stand over 35 feet high above the floor and the top of each is reached by curved stairways which, with their brass hand-rails, present a pleasing effect to the eye, while they emphasize the great power and size of the engines. Iron platforms, bolted to the frames of the engines, enable the attendants to reach quickly any part of the exterior. Counting these platforms as stories, the tops of the engines—reached by ladders from the top platforms—may be said to be four stories above the ground.

Each engine comprises two vertical cylinders erected side by side on massive frames, bolted to ponderous bed-plates. In each engine there is room left between the two cylinders for a generator, which will furnish current for light and power. The revolving part of this generator is mounted directly upon the steel shaft of the engine, and is firmly bolted to a very heavy flywheel. Perhaps a better idea of the size of the machines may be obtained by noting that the flywheel of each has in the rim alone 100 tons of metal, that it is 28 feet in diameter, and that the shaft which carries it is 39 inches in diameter. It is not feasible to build so large a flywheel in one piece; and it is accordingly built in segments, keyed to each other, and all bolted to the hub.

In addition to the great mass of the engine which is visible above the floor, a considerable depth below the floor is necessary to allow space for the flywheel and the lower frames of the great generator. Then, under all, when the machines are permanently installed, will be foundations of concrete. The overall length of each of these great engines is approximately 40 feet.

Engineers will be interested in the following additional data. The engines are cross-compounded with intermediate reheating receivers. The high and low-pressure cylinders are of 46 and 86 inches diameter, respectively, and both are equipped with a new form of Corliss valve gear. The stroke is 60 inches and the speed is 75 revolutions per minute.

Steam is supplied at a pressure of 180 pounds and the normal horse-power of the engines is 4,000.

The engines are of the vertical, cross-compound condensing type, especially designed for driving alternating-current generators mounted directly on the shaft of the engine. The engines have a nominal capacity of 4,000 horse-power, and will carry successfully overloads of 7,500 horse-power. The principal dimensions of the engines are as follows:

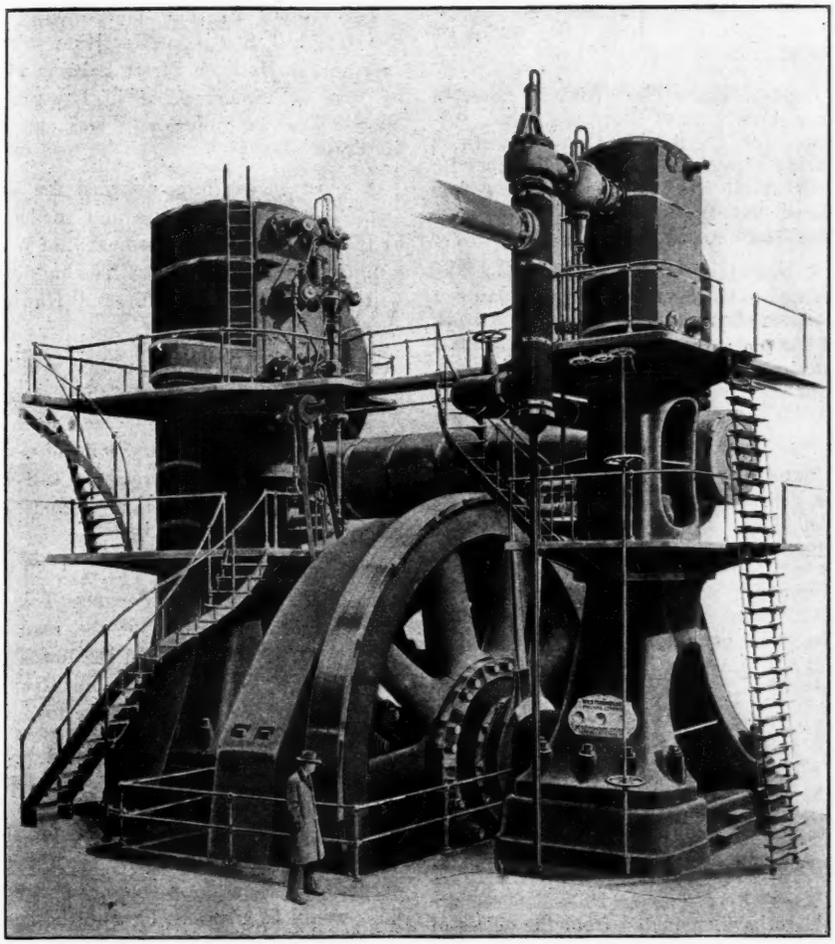
Height from floor line to top of cylinders, about 35 feet; length along the shaft, 38 feet 6 inches; diameter of high-pressure cylinder, 46 inches; diameter of low-pressure cylinder, 86 inches; stroke, 60 inches; number of revolutions per minute, 75; steam pressure, 170 pounds. The diameter of the shaft in the centre is 39 inches; diameter of shaft at bearings, 34 inches; length of each bearing, 60 inches; total weight of the shaft without crank-cheeks or flywheel centres, about 75,000 pounds. The shaft is of hydraulic forged O. H. steel, having a hole its entire length 16 inches in diameter. The flywheel is very massive, having 100 tons in the rim; diameter of wheel, 28 feet; velocity of rim, 6,600 feet per minute, or practically one and one-quarter miles.

The generators, of the Westinghouse engine type, have an output of 2,850 kilowatts each, giving a three-phase current of 250 amperes in each phase, at 6,600 volts, with 50 cycles per second. They have separately excited fields and operate in multiple with other units.

Building engines of such great size calls for unusual shop and foundry facilities and even their shipment is by no means an insignificant problem. Thus, for instance, the two great bed-plates of one of these engines weigh over 43 tons each, and as they are cast complete in one piece they are very difficult to handle. For transporting these enormous castings to Brooklyn the Pennsylvania Railroad has constructed special steel cars. The flywheel is built up in segments, and each of these segments is a car load. The cylinders are also ponderous pieces of metal, and it will readily be seen that to dismember the engines, pack, ship and reassemble them, is a difficult undertaking.

The company for which these engines were built was chartered in 1890. Later, the charter was taken over by Mr. A. M. Young, of Waterbury, Ct. By January of 1898, 82 miles of conduit had been laid, all done under the most exacting specifications. In 1898 the Gold street station of the company was begun, and this was equipped with Westinghouse generators. Both this and the new Bay Ridge station are of modern fireproof construction, with foundations of concrete on top of piles. Landing docks have been built close to the stations for handling coal and ashes, and the most approved modern station methods have been adopted. The Bay Ridge station, to which the new engines are to be shipped, has already in use about 5,000 horse-power of generating apparatus, and when the two new 5,000-horse-power units are installed, it will be one of the largest in the country.

Besides the two engines described above, the same company is building a large number of similar and even more powerful engines, notably 16 engines of 5,000 horse-power each for the Third Avenue Railroad, of New York; two engines of the same capacity for the Boston Elevated Railway; two engines, of 1,500 horse-power, for Manchester, England, and eight engines, of 6,500 horse-power, for the new Waterside power-plant of the New York Gas, Electric Light and Power Company, and a great number of smaller equipments.



LARGE ENGINES FOR THE KINGS COUNTY ELECTRIC LIGHT AND POWER COMPANY.

Largest Generator in Rochester, N. Y.

The Rochester Railway Company has recently installed a new generator of 500-kilowatt capacity, operated by a cross-compound condensing Corliss engine of 1,200 horse-power. This is the largest generating set in the city of Rochester and it is expected that the energy derived from the new generator will be sufficient to more than meet the demands of the company's street-car system. The engine which operates the generator weighs 30 tons and has a flywheel of 18 feet diameter, its pistons being 17½ feet in length. Three small engines which operated 100-kilowatt generators each were replaced by the new engine, which furnishes two-thirds as much energy again as its predecessors. In addition to the new set the company has now 12 small generators and obtains in addition 500 horse-power daily from the Rochester Gas and Electrical Company. Manager Nicholl, of the railway company, stated that he expected the additional energy furnished by the new machine to obviate much of the tedious delay of the company's cars due to overload in the Winter season, as more power is required at that time of year to successfully operate the system than in the Summer.

Corporation News

JEFFERSON CITY, MO.—Reynolds County Telephone Company, of Centreville; $1,000. Incorporated by J. T. Dobbins, J. F. Rayfield and others.

COLUMBUS, OHIO—An increase of $900,000 has been certified to by the Scioto Valley Traction Company. The figures now reach $1,000,000.

ALBANY, N. Y.—The Herkimer County Light and Power Company has filed, recently, a certificate of a reduction of its capital from $500,000 to $400,000.

DOVER, DEL.—Northwestern Telephone and Telegraph Company, to construct and operate telephone, telegraph and an electric light and power plant; $200,000.

TRENTON, N. J.—Long Island Electric, Gas and Water Company; $500,000. Incorporators: G. H. B. Martin, F. R. Hansell and Max Phillips, all of Camden.

ROCKVILLE WATER COMPANY, Rockville. To supply water and electric light; $25,000. Incorporators: E. S. Bonbeck, R. Dosley, C. H. Humincutt, all of Rockville.

DOVER, DEL.—Northwestern Telephone and Telegraph Company, of Carthage, N. Y., to construct and operate telephone, telegraph, lighting and power plants; $2,000,000.

CENTRAL ENERGY TELEPHONE COMPANY, Frankfort. To operate telephone lines; capital, $30,000. Incorporators: J. H. Murphy, M. W. Hopkins, W. Payne, all of Indianapolis.

MILWAUKEE, WIS. — An increase of $140,000 has been voted to the capital stock of the Milwaukee Electric Company to meet the demands of its constantly increasing business.

THORNTOWN ELECTRIC LIGHT COMPANY, Thorntown. To manufacture and generate electricity; capital, $15,000. Incorporators: A. N. Hodgen, R. A. Ashe, R. Bamberger, all of Thorntown.

TRENTON, N. J.—Empire City Gas and Electric Company; $500,000. To supply heat, light and power. Incorporators: George W. Lynch, Martin Caflesch and John T. Underhill, all of Jersey City.

LOUISVILLE AUTOMOBILE CAB COMPANY, New Albany. To operate cab and transfer service; $25,000. Incorporators: P. Arlund, J. A. Windsor, W. H. Sarvant, C. Dollom, G. W. Hester, all of New Albany, Ind.

INDIANAPOLIS, IND.—Northern Indiana & Southern Michigan Telegraph Company, of Lagrange, to establish telephone and telegraph lines. Incorporators: A. J. Hostetter, R. Ellison, A. H. Ellison, all of Lagrange.

PUEBLO, COLO.—Pueblo Traction and Lighting Company, to construct an electric railway and carry on a lighting service; $1,500,000. Incorporators: W. Rice, J. F. Vail, C. E. Gast, T. H. Devine, M. D. Thatcher, all of Pueblo.

FRUITVALE, CAL.—A charter has been granted to the Fruitvale Light, Heat and Power Company, at Sacramento. The capital stock of the new company is $100,000. Fruitvale and San Francisco capitalists are behind the scheme.

CHICAGO, ILL.—The Peoria Gas and Electric Company has recently certified to an increase of its capital to $1,000,000, thus doubling its stock, and the Carlinville Telephone Company has raised its capital from $5,000 to $30,000.

ELGIN, ILL.—The Western Reserve Trust Company, of Cleveland, Ohio, purchased the Elgin City, Carpentersville & Aurora Electric Railway, on December 10. The capital stock of the company purchased was $500,000 and the purchase price $1.10 on the dollar.

RAUBSVILLE, N. J.—A charter has been granted to the Lehigh Power Company, of Northampton County. The capital stock of the new concern is $300,000, in 3,000 shares of common stock. Electric heat, light and power will be furnished. Philadelphia capitalists are said to be interested.

TRENTON, N. J.—The New Jersey Motor Vehicle Company, Jersey City, N. J.; $250,000. Incorporators: Theodore W. Bergen, of Jersey City; R. B. Constantine, of West Orange; George F. B. Hanford, of Orange; R. W. Weissenborn, of Jersey City; Frank Bourne, of New York, and George H. Bruce, of Plainfield.

ALBANY, N. Y.—Capital County Light, Heat and Power Company, of Watervliet; capital, $25,000. Directors: D. S. Johnston and J. E. MacLean, Cohoes; Robert Williams, Watervliet. Subscribers' Telegraph and Telephone Company, of Watervliet; $15,000. Directors: D. S. Johnston and J. E. MacLean, Cohoes; S. J. Cavanaugh, Watervliet.

EAST PITTSBURGH, PA.—Reports are said to have emanated from the offices of the Westinghouse Electric and Manufacturing Company to the effect that the capital stock of that corporation may be raised to $30,000,000, or exactly double the present capitalization. This is intended to meet the growing demands of the Westinghouse company's business. The report is unconfirmed to date.

HARRISBURG, PA.—United Telegraph and Telephone Company, of Philadelphia; $10,000. Reading & Birdsboro Railway Company; $100,000. Reading & Hamburg Railroad Company; $150,000. The directors are John A. Rigg, Robert N. Corson, Richmond L. Jones, Edward J. Moore, Thomas C. Barr, Henry C. Moore, Walter A. Rigg, R. Nelson Buckley, Albert J. Brumbach, William R. McIlvain, James A. O'Reilly and Jerome L. Boyer.

Electric Railways

A large power-house will be built by the Penhale-De Witt Syndicate in Youngstown, Ohio, to supply the various companies in that city and Sharon.

An official of the Consolidated road of Winsted, Ct., is said to have stated that his company will not extend the third-rail system westward to Waterbury, as the cost will be too great.

The site of the new power-house of the Haverhill, Southern New Hampshire, Lawrence & Methuen Street Railway will be near the Salem depot in Lawrence, Mass. The building will cost about $20,000.

A contract has been awarded for the erection of a power-house and car-barn by the People's Railway Company, of Wilmington, Del., for $40,000. The building will be located near Fifth and Hawley streets.

Several trolley ordinances were discussed at a recent meeting of the Passaic, N. J., council, and the trolley men in that city secured what they asked for and went away rejoicing. Improvements will be made and several important reforms in the service instituted.

Another electric road is to be built in Ohio in the near future to connect Toledo and Defiance. The cost of the road is estimated at $2,000,000 and the towns of Waterville, Florida, Grand Rapids, Napoleon, Liberty and Jewell will be touched as intermediate points.

The strike that has been for some time past affecting the Key West, Fla., street car lines has assumed serious aspects, and the Key West Electric Company has threatened to withdraw from the city entirely. This would be a serious blow to the business portion of the city.

A report from Youngstown, Ohio, states that the Consolidated Gas and Electric Company, which recently purchased all the lighting plants in that city, has been granted a 25-year franchise to construct a line to Struthers, where it will erect a large light and power plant.

Numerous citizens of Newport, R. I., are agitating a trolley line. Efforts have been made before to secure one, but they have been ineffectual up to date. It is believed that the present line will not materialize as all previous efforts have failed, but a determined effort will be made on this occasion.

A petition will soon be presented to the Maine Legislature for permission to discontinue the running of its electric cars in the towns of Skowhegan and Norridgewock, by the Skowhegan & Norridgewock Railway and Power Company, as the road has proved a losing venture since it was built in 1894.

After January 10 of this year the plant of the Empire State Power Company, at Schoharie Falls, N. Y., will transmit 1,500 horse-power to Howes Cave. When the season of drought arrives work will be well underway on the big storage reservoirs of the company, one of which will be located between Blenheim and Gilboa.

Applications have been filed with the Utica, N. Y., city authorities for permission to construct and operate an extension through South street in that city to Washington Mills, and from there through Willowvale to Chadwick, by the Utica Suburban Railroad Company. Another extension is planned, and both will run through the Sauquoit Valley.

The falling of a motor-box recently in a car of the Loomis street line in Williamsburgh, Greater New York, injured several persons. The box became dislodged and dropped to the roadway, putting out all the lights in the car. Considerable confusion ensued, and several women were injured in the crush that followed to get out of the car. The damage was estimated at about $500.

Prominent citizens of Algiers, La., are desirous of having an electric road of their own, and the first steps toward the realization of the project will be the paving of Prytania street and the raising of sufficient money to ensure the building of the road. A New Orleans real estate man thinks that real estate values in New Orleans, and Algiers as well, would unquestionably be improved by the proposed line.

A United States mail wagon and a Third Avenue trolley car recently engaged in a friendly wrestling match in New York city, greatly to the detriment of the former. The wheels of the wagon were smashed, the driver was thrown 20 feet away, and every pane of glass in the car windows was shattered. Two persons were quite badly injured and taken to the hospital, while registered letters were distributed in bunches over quite an area.

A change was recently instituted in the power of the Fall River, Warren & Bristol Railroad of Massachusetts, changing it from steam to an electric line. A good deal of trouble was experienced owing to the greenness of the men and the fact that the new cars and appliances were not perfectly adapted to the service required of them. An outward bound train was partly derailed and considerable commotion was caused by the accident, several people being quite badly injured.

The Illinois Central Railroad, of Chicago, refuses to say positively what will be done with the increase in its capital stock, from $60,000,000 to $66,000,000, but the report was recently circulated that the six millions will be used to change the equipment of the company's suburban line from steam to electricity. This would redound to the advantage of the road, saving about 75 per cent in operating expense, doing away entirely with the smoke nuisance and permitting faster time.

For three years past there has been a bitter fight between the two Staten Island electric railroad companies. This doubtless has been settled, the Staten Island Electric Railroad management having secured the property consents for a road to connect South and Midland beaches. Work was to have been begun last Spring, but owing to local entanglements it was postponed. It is said that the Midland Railroad is to be absorbed by the other older road, but this report lacks confirmation.

A suit has been instituted by the city of Worcester against the Worcester Consolidated Street Railway Company for refusing to issue three-cent-fare tickets to school children. The law specifies that all school children shall be carried for one-half the regular fare and that tickets shall be sold them in books of ten, the penalty for each failure to comply with the law being a fine of $25. The suit will be followed with considerable interest as it is really instituted to test the constitutionality of the act.

President H. H. Vreeland, of the Metropolitan Street Railway Company, of New York city, said in an interview recently: "I have repeatedly denied the rumor that Metropolitan would lease or in some other way acquire the Manhattan elevated line, and I again emphatically deny it. The fact that we are supplying power for the operation of the Manhattan company's experimental train only shows that street railroad companies are sinking their petty differences and assisting one another in difficulties, as the steam railroads do."

Well-to-do farmers and property owners along the road leading from Metuchen and Perth Amboy, N. J., are objecting to the franchise granted to the Raritan Traction Company for the right to construct a street railway over that thoroughfare. The objection is based on the ground that the railroad would ruin the roadbed, it having very recently been macadamized and is one of the finest in the state. It is also believed by the parties interested that it would injure their property values as the trolley company wishes to construct the tracks on the side adjoining their land. Counsel has been retained and a strong fight will be made.

A device for operating all surface switches automatically is being tested by the St. Louis, Mo., Traction Company. The apparatus consists of three parts; the switch employed between the rails, a cutout attached to the trolley wire near the switch, and a solenoid magnet fastened to one of the poles on which the feed wires are strung. The contact or absence of contact of the trolley wheels with the cutout throws a current through the magnet which operates the switch lever. If the motorman desires his car to move straight ahead he turns off his power a few yards away from the switch, but if he wishes to take the curve he leaves his power on.

Some of the figures compiled by the statistician of the Dominion of Canada, regarding electric railways in that province, are of considerable interest. During the year ending December 31, 1899, 20,646,347 miles were run and 104,933,659 passengers were carried. This is said to be equal to carrying every man, woman and child in the Dominion of Canada twenty times. The mileage run and passengers carried show that for each mile the electrics carried three and one-half passengers. Compared with the previous year the number of passengers increased nearly nine and one-half millions, and the number of miles run by over one million. The paid-up capital invested in the enterprise is nearly $21,700,000. Transfers are said not to be included in the total of passengers carried.

An important trolley line consolidation has been effected in Philadelphia by Messrs. Stern and Silverman, who have leased the Philadelphia & Chester Railway Company and the Southwestern Railway Company to the Chester Traction Company for 999 years. This gives the Chester Traction Company a clear right of way from the heart of Chester to the southern boundary of Philadelphia, at Third and Jackson streets, and Third and Tasker streets, from which points the run will be made to Chester in 40 minutes. Under the lease, the Chester Traction Company guarantees the interest on the bonds of the underlying companies, and has placed their stock in its treasury. The Philadelphia & Chester Railway Company is capitalized at $350,000, and bonded at $350,000. The Philadelphia & Southwestern Railway Company is capitalized at $450,000 and bonded at $450,000. The through line will be completed within the next 60 days, as only another 4,000 feet of track remains to be laid.

Industrial Notes

THE AMERICAN BRIDGE COMPANY is furnishing, from its Lafayette plant, five bridges for Montgomery County, Ind.

THE ASHTON VALVE COMPANY, Boston, Mass., has issued its calendar for the ensuing year, bearing upon its face a photogravure entitled "Please Bite." It represents a fishing scene.

JOSEPH DIXON CRUCIBLE COMPANY, Jersey City, N. J., has issued a little pamphlet entitled "Where the New Century Will Really Begin." The pamphlet contains descriptive matter of the company's pencils and graphite productions.

THE CHARTER GAS ENGINE COMPANY, Sterling, Ill., will send, upon application, its pamphlet entitled "The Charter Gas and Gasoline Engine." This is an attractive little book, neatly gotten up and illustrating the company's products.

THE HOMER COMMUTATOR COMPANY, Cleveland, Ohio, has issued two blotters bearing upon their faces verses entitled "Homer of Cleveland *versus* Homer of Greece." The blotters will be sent by the company to any one interested.

THE NEW ERA IRON WORKS COMPANY, Dayton, Ohio, has issued a very attractive pamphlet on its gas and gasoline engines. Full descriptive matter and complete illustrations are contained in the book, which will be sent upon application to the company.

THE GARVIN MACHINE COMPANY, New York city, has issued a neat little booklet on modern 16-inch shapers Garvin type. The pamphlet is printed in red and black and contains illustrations of the machines and the work that they do with full specifications.

THE VIADUCT MANUFACTURING COMPANY, Baltimore, Md., is sending out, with its compliments and best wishes for the New Year, a dainty memorandum book containing a calendar for 1901 and data of general interest. The book is artistically gotten up in white celluloid cover and is a handy and useful article for pocket use.

THE AMERICAN STEEL HOOP COMPANY is going to put in steel bins at its Isabella Furnaces, at Aetna, Pa. This will require about 750 tons of steel, which will be furnished by one of the Pittsburgh plants of the American Bridge Company. The bins will be made in accordance with the design of Julian Kennedy, mechanical engineer.

THE SAFFORD ARC LAMP COMPANY, Buffalo, N. Y., has been awarded the order for arc lamps for the lighting of the United States Government buildings at the Pan-American Exposition. This is considered quite a victory for this company, as this award was not placed until the most careful and discriminating comparisons had been made.

THE AUTOMATIC SWITCH COMPANY, of Baltimore, Md., announces that it has been installing a large quantity of its automatic rheostats for electric elevator service. It states that it can supply them in sizes ranging from one-half to 125 horse-power, and that they are suitable for elevators, hoists, dumb-waiters, pumps for pressure and roof tanks.

THE INDUSTRIAL WATER COMPANY has recently issued a pamphlet entitled "Pure Water for Steam Boilers," being a reprint from the *Railroad Gazette*. Accompanying this pamphlet is a larger book of similar nature containing lists of the company's machines, descriptions of its automatic water softeners and general matter of interest to steam boiler users.

"THE SPIRIT OF NIAGARA" is the title of a handsome poster issued by the Pan-American Exposition, of Buffalo, N. Y. The poster is magnificently gotten up in pale blue and gold and represents a beautiful young woman with extended arms as the Spirit of Niagara, suspended in the Falls. It is a very attractive poster and a most excellent piece of lithographic work.

THE MOTOR POWER COMPANY, of London, England, is building a 16-horse-power, four-cylinder Napier auto-car for Mr. Charles J. Glidden, president of the Erie telephone system. The machine will be equipped with all the latest improvements, including air brake, pumping attachment to the engine for inflating tires, electric igniting and adequate governing gear to prevent engine-racing.

THE EMERSON ELECTRIC MANUFACTURING COMPANY, St. Louis, Mo., has issued a slip containing an illustration and descriptive matter of its automatic illumination cylinder for electric signs and decorations. On the reverse of the blank is a form of application which, on being filled out, will bring to the inquirer fuller descriptive matter and further information as desired.

G. A. CROSBY & COMPANY, 2836 Archer avenue, Chicago, Ill., owns and operates the plant of the E. S. Stiles Press Company, formerly of Watertown, N. Y., and is sending out a postal-folder containing engravings of its plants with general descriptions and illustrations of its machines, which include presses, slitting shears and complete plants which it manufactures for the automatic making of cans.

THE CENTRAL TELEPHONE AND ELECTRIC COMPANY, St. Louis, Mo., has issued its seventh annual catalogue for the year 1901. The little book is attractively gotten up and contains cuts and descriptive matter in brief of the telephone apparatus the company makes and handles. A complete catalogue of instruments and supplies will be mailed upon application to the office, 909 Market street.

H. J. LEONARD & COMPANY, of 123 Liberty street, New York city, are calling the attention of the electrical field to their new "Perfect" enclosed arc lamp. The company maintains that it is specially adaptable on account of its small consumption of current and the steadiness of its lights. In construction it is small, compact and ornamental, and specially adapted for stores, etc., where steadiness of light is in a great degree necessary.

ARTISTIC CALENDARS have been issued for the ensuing year by the American Electrical Works and the Direct United States Cable Company, Limited. That of the American Electrical Works bears upon its face a portrait of Faraday, while the cable company's calendar is of the pad variety, mounted upon heavy cardboard and illustrated with figures of Columbia and Britannia clasping the hands of a sprite, presumably the cable.

THE J. G. BRILL COMPANY, Philadelphia, Pa., is sending out a pamphlet illustrating its patented round corner seat end panels for open electric cars. The book contains a bird's-eye view of the works of the company, illustrations of the cars fitted with the panels and descriptive matter of considerable interest. It is bound in green and stamped in black and gold. The company will send the pamphlet to any street railway man interested in the subject.

W. H. ALLEN, SON & COMPANY, Limited, Bedford, England, will send to engineers, upon application, its handsome new book entitled "Electric Transmission of Power," in which is contained full descriptive matter of the company's machinery and copious illustrations. The book is very attractively gotten up on heavy calendered paper, with numerous half-tone engravings, and is printed in black and red. The binding is of imitation morocco, stamped in gold.

THE NEW ERA IRON WORKS COMPANY, Dayton, Ohio, manufacturer of gas and gasoline engines, has recently published a catalogue of its products, embodying descriptive matter and copious illustrations showing gas and gasoline engines for all purposes. Tables are printed in the back of the book showing sizes and dimensions, with descriptive matter of its horizontal pumps, both single and double acting, and concluding with five pages of testimonials.

THE AMERICAN ELECTRIC FUSE COMPANY, Chicago, Ill., is issuing a pamphlet describing its lightning arresters, connectors, fuse blocks, etc. The manufacturer claims that this is the only thing of the sort ever issued in the history of the telephone business and will prove of assistance in locating trouble and preventing loss and damage which otherwise might result. The company also desires to call attention to its new guarantee, whereby it agrees to take care of all apparatus for one year after date of purchase without charge in case any goods are found in any way defective. It also has a number of second-hand telephones of standard make on hand which it will be glad to sell at reasonable prices, and which are said to be as good as new.

THE RELIABILITY and convenience of an automobile service were shown to splendid advantage last week in Atlantic City, where the Electric Vehicle Company maintains a service for the hotels. Twelve inches of snow fell on Friday last, blocking railroads, trolley cars and nearly all the public conveyances. The automobiles, however, continued to operate almost with the same degree of regularity as under normal conditions of traffic. Those of the cabmen who were able to weather the storm with their conveyances, sought to make of it a golden opportunity for extortionate rates. The automobile service ran under its regular rates and won general favor for its serviceableness in the emergency. A similar situation was encountered during a recent snow-storm at Lakewood, where a Columbia automobile carries the guests of the Lakewood Hotel and the station. There was no interruption in the service and patrons were carried between the hotel and the railroad station without any delay.

THE KEYSTONE ELECTRICAL INSTRUMENT COMPANY, of Philadelphia, has installed a complete stock of its well-known electrical measuring instruments in its New York offices, 15 Cortlandt street. A portion of this stock is on exhibition and the balance will be held packed ready for shipment in the company's New York storeroom. The stock carried covers combination portable voltmeters for all ranges up to 300 volts, single or double scale; combination portable ammeters; combination portable wattmeters; direct-current portable voltmeters, from 10 to 600 volts; direct-current portable ammeters up to 250 amperes; switchboard instruments in illuminated dial, type K and type R cases, in all ranges up to 600 volts and 500 amperes; arc ground detectors; constant-potential ground detectors; potential indicators and vehicle instruments. The ammeters are of both the series and shunt types. The Keystone Electrical Instrument Company is desirous that the electrical public should know that these instruments are actually carried in stock and that besides enabling the company to show the complete scope of its products this new departure will enable it to fill any emergency orders. The company believes it is the only instrument company that has adopted such a policy and it is expected that the electrical fraternity in New York and vicinity will appreciate the convenience.